NASA

Aeronautical Engineering
A Continuing Bibliography with Indexes

NASA SP-7037 (115)
November 1979

National Aeronautics and Space Administration

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NASA SP-7037(115)

AERONAUTICAL ENGINEERING

A Continuing Bibliography

Supplement 115

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in October 1979 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*

Scientific and Technical Information Branch 1979
National Aeronautics and Space Administration
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INTRODUCTION

Under the terms of an interagency agreement with the Federal Aviation Administration this publication has been prepared by the National Aeronautics and Space Administration for the joint use of both agencies and the scientific and technical community concerned with the field of aeronautical engineering. The first issue of this bibliography was published in September 1970 and the first supplement in January 1971. Since that time, monthly supplements have been issued.

This supplement to *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 273 reports, journal articles, and other documents originally announced in October 1979 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*.

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged in two major sections, *IAA Entries* and *STAR Entries*, in that order. The citations, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* and *STAR*, including the original accession numbers from the respective announcement journals. This procedure, which saves time and money, accounts for the slight variation in citation appearances.

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All publications abstracted in this bibliography are available to the public through the sources as indicated in the *STAR Entries* and *IAA Entries* sections. It is suggested that the bibliography user contact his own library or other local libraries prior to ordering any publication inasmuch as many of the documents have been widely distributed by the issuing agencies, especially NASA. A listing of public collections of NASA documents is included on the inside back cover.

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N79-10024*# Northrop Corp., Hawthorne, Calif. Aircraft Group.
STUDY OF AERODYNAMIC TECHNOLOGY FOR VSTOL FIGHTER/ATTACK AIRCRAFT: HORIZONTAL ATTITUDE CONCEPT Final Report
S. H. Brown May 1978 242 p refs Sponsored in part by the David Taylor Naval Ship Research and Development Center, Bethesda, Md.
(Contract NAS2-9771)
(NASA-CR-152130; NOR78-54) Avail: NTIS HC A11/MF A01 CSCL 01A

A horizontal attitude VSTOL (HAVSTOL) supersonic fighter attack aircraft powered by RALS turbofan propulsion system is analyzed. Reaction control for subaerodynamic flight is obtained in pitch and yaw from the RALS and roll from wingtip jets powered by bleed air from the RALS duct. Emphasis is placed on the development of aerodynamic characteristics and the identification of aerodynamic uncertainties. A wind tunnel program is shown to resolve some of the uncertainties. Aerodynamic data developed are static characteristics about all axes, control effectiveness, drag, propulsion induced effects and reaction control characteristics. G.Y.

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A79-10266 * # **An experimental study of three-dimensional turbulent boundary layer and turbulence characteristics inside a turbomachinery rotor passage.** A. K. Anand and B. Lakshminarayana (Pennsylvania State University, University Park, Pa.) *(American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, London, England, Apr. 9-13, 1978, Paper 78-GT-114.)* ASME, Transactions, *Journal of Engineering for Power,* vol. 100, Oct. 1978, p. 676-687; Discussion, p. 688-690. 19 refs. Grant No. NGL-39-009-007.

Three-dimensional boundary layer and turbulence measurements of flow inside a rotating helical channel of a turbomachinery rotor are described. The rotor is a four-bladed axial flow inducer operated at large axial pressure gradient. The mean velocity profiles, turbulence intensities and shear stresses, and limiting stream-line angles are measured at various radial and chordwise locations, using rotating triaxial hot-wire and conventional probes. The radial flows in the rotor channel are found to be higher compared to those at zero or small axial pressure gradient. The radial component of turbulence intensity is found to be higher than the streamwise component due to the effect of rotation. Flow near the annulus wall is found to be highly complex due to the interaction of the blade boundary layers and the annulus wall resulting in an appreciable radial inward flow, and a large defect in the mainstream velocity. Increased level of turbulence intensity and shear stresses near the midpassage are also observed near this radial location. (Author)

AERONAUTICAL ENGINEERING

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IAA ENTRIES

A79-43946 # **Parameter and state estimation applicable to aircraft identification problem.** K. Kanai (National Defense Academy, Yokosuka, Kanagowa, Japan), P. N. Nikiforuk, and M. M. Gupta (Saskatchewan, University, Saskatoon, Canada). *Japan Society for Aeronautical and Space Sciences, Transactions,* vol. 22, May 1979, p. 1-15. 6 refs.

The problem considered in this paper is the estimation of the states and parameters of an nth-order linear system where only the input and output can be observed. A new canonical form suitable for simple adaptive observer synthesis is defined. The computational algorithm which represents the convergence of the identification scheme is derived. Proof of convergence is provided without using such techniques as the Liapunov function. Computational results for a VTOL aircraft estimation problem show that the implementation is very simple and the convergence is quite rapid. S.D.

A79-43993 # **Modern concepts for design of delta wings for supersonic aircraft of second generation.** A. Nastase (Aachen, Rheinisch-Westfälische Technische Hochschule, Aachen, West Germany). *(Gesellschaft für angewandte Mathematik und Mechanik, Wissenschaftliche Jahrestagung, Brussels, Belgium, Mar. 28-31, 1978.) Zeitschrift für angewandte Mathematik und Mechanik,* vol. 59, May 1979, p. T 246-T 248. 8 refs.

A fully optimal delta wing (called Model-Adela I-Aachen) has been realized for second generation supersonic aircraft. This wing model is convex in the neighborhood of its apex and assumes a wavy shape in the neighborhood of the trailing edge. The wing is angular along the leading edges and sharp along the trailing edges. Theory predicts that this fully optimized wing has half the frictionless drag of an equivalent planar delta wing flying at the same cruising speed. B.J.

A79-44083 **Effect of inertia of blower on stability of air-cushion vehicle.** L. A. Maslov and Ia. G. Panovko. *(Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela,* Sept.-Oct. 1978, p. 51-54.) *Mechanics of Solids,* vol. 13, no. 5, 1978, p. 44-48. Translation.

A theoretical analysis is used to investigate small vertical translational oscillations of an air cushion vehicle. Particular consideration is given to the role of inertia of the blower system. B.J.

A79-44094 # **Longitudinal dynamic stability of a hovering helicopter with a sling load (Podluzna statecznosc dynamiczna smiglowca z podwieszonym ladunkiem w zawisie).** W. Lucjanek and K. Sibilski (Warszawa, Politechnika, Warsaw, Poland). *Mechanika Teoretyczna i Stosowana,* vol. 17, no. 2, 1979, p. 263-276. 11 refs. In Polish.

A physical model of a single-rotor helicopter with a sling load is developed, and the equations of the hovering helicopter are derived. A stability analysis of the system in banking and in horizontal flight is carried out by the method of small perturbations of the equilibrium state. The modes of helicopter motion are identified, along with the influence of the magnitude of the load, the length of the sling, and the location of its point of attachement on the stability of the system. V.P.

A79-44451 **Service fatigue loads monitoring, simulation, and analysis; Proceedings of the Symposium, Atlanta, Ga., November 14-15, 1977.** Symposium sponsored by the American Society for Testing and Materials. Edited by P. R. Abelkis (Douglas Aircraft Co., Long Beach, Calif.) and J. M. Potter (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). Philadelphia, Pa., American Society for Testing and Materials (ASTM Special Technical Publication, No. 671), 1979. 289 p. $29.50.

The symposium focuses on fatigue and fracture control and emphasizes the need for more precise analytical definition and testing simulation of the fatigue cyclic loading environment for higher reliability in structural design. Papers cover aircraft, bridge, ship, crane, and ground transportation fields. Specifically, papers on random load analysis as a link between stress measurement and fatigue life, aircraft load monitoring, assessing service load experience, a crack-growth gage for monitoring fatigue cracks, flight spectra development for fighter aircraft, gust spectra prediction of fatigue damage, simulation of loads in crane beams, and test simulation of fighter aircraft maneuver load spectra are presented. A.T.

A79-44453 **State of the art in aircraft loads monitoring.** L. E. Clay, A. P. Berens, and R. J. Dominic (Dayton, University, Dayton, Ohio). In: Service fatigue loads monitoring, simulation, and analysis; Proceedings of the Symposium, Atlanta, Ga., November 14-15, 1977. Philadelphia, Pa., American Society for Testing and Materials, 1979, p. 21-35. 6 refs.

The paper summarizes current state-of-the-art equipment and techniques for the monitoring of loads during military aircraft operation. Monitoring systems are discussed which record strain, center-of-gravity motions, and control deflections, or the occurrence of selected load conditions. The raw data are reduced to sequences of stress peaks and troughs or to tabulations of peaks and coincident values of the recorded parameters. Finally, monitoring system cost estimates are provided for typical applications to individual aircraft tracking and loads and environmental spectra survey problems. (Author)

A79-44454 **Determination of sample size in flight loads programs.** A. P. Berens (Dayton, University, Dayton, Ohio). In: Service fatigue loads monitoring, simulation, and analysis; Proceedings of the Symposium, Atlanta, Ga., November 14-15, 1977. Philadelphia, Pa., American Society for Testing and Materials, 1979, p. 36-47. USAF-supported research.

This paper describes the application of a statistical model of a cumulative damage index to the problem of determining the number of flights to be monitored in aircraft operational usage programs based on samples of flights. The method can be used to calculate the optimum number of flights to achieve given precision and confidence under stratified sampling. It also provides a method for determining precision at any level of confidence given a sample size. Examples of the use of the techniques are provided using data from the operational usage programs of three aircraft types. (Author)

A79-44455 **Use of AIDS recorded data for assessing service load experience.** J. B. de Jonge and D. J. Spiekhout (National Lucht- en Ruimtevaartlaboratorium, Amsterdam, Netherlands). In: Service fatigue loads monitoring, simulation, and analysis; Proceedings of the Symposium, Atlanta, Ga., November 14-15, 1977. Philadelphia, Pa., American Society for Testing and Materials, 1979, p. 48-66.

Results of the aircraft integrated data system (AIDS) recorded aircraft mission profile data and information on loading environment are presented. All primary aircraft structures must be regularly inspected for fatigue cracking. The inspection periods and safe service lives of transport aircraft are based on an assumed average design load, corresponding to average usage under average environmental conditions. However, the actual load experience may deviate appreciably from these assumptions, and therefore AIDS system was developed to extract on a routine basis fatigue load related data for the 747 aircraft. AIDS criteria including time interval, flight mode, and limit exceedance, acquisition of fatigue-relevant load data, load data extraction, data quality assurance, data storage, and analysis of fatigue load data are discussed. Finally, data analysis results and examples of aircraft usage are tabulated. A.T.

A79-44456 **Overview of the C-5A Service Loads Recording Program.** W. J. Stone, A. M. Stanley, M. J. Tyson, and W. H. Kimberly (Lockheed-Georgia Co., Marietta, Ga.). In: Service fatigue loads monitoring, simulation, and analysis; Proceedings of the Symposium, Atlanta, Ga., November 14-15, 1977. Philadelphia, Pa., American Society for Testing and Materials, 1979, p. 67-83. 8 refs.

The United States Air Force (USAF) C-5A Service Loads Recording Program (SLRP) was initiated in the early 1970s to acquire in-service data in sufficient quantity to define the operational environment of an 'average' C-5A and to develop repeated loads (stress) spectra for applications in loads and fatigue analyses. Instrumentation was installed on 26 airplanes to record up to 53 different data parameters on magnetic tape by means of the C-5A MADARS recorder. Over 9000 h of usable operational data were acquired in the course of the program. Using these measured data along with current analytical data for wing stresses, airplane vertical acceleration, and other responses, analyses were conducted for 13 different load sources. The results were new criteria and modified analytical wing loads which were used in the design phase of the C-5A Wing Modification Program and in the updating of service life predictions made by the C-5A Individual Aircraft Service Life Monitoring Program. (Author)

A79-44457 **Highlights of the C-141 service life monitoring program.** D. S. Morcock (Lockheed-Georgia Co., Marietta, Ga.). In: Service fatigue loads monitoring, simulation, and analysis; Proceedings of the Symposium, Atlanta, Ga., November 14-15, 1977. Philadelphia, Pa., American Society for Testing and Materials, 1979, p. 84-93.

The paper presents the C-141A aircraft structural integrity program, with emphasis on the service life monitoring and life history recording program activities. The structural integrity program requirements including static strength and fatigue analyses are described. The service life monitoring includes service life analyses utilizing velocity-acceleration-altitude and ground load data, and fatigue endurance life for fatigue-susceptible locations on the airframe. A life history recording program monitors the actual operational environment and response by onboard recorders which read aircraft speed, normal load factor, altitude, and strain level. In summary, the C-141A service life monitoring program is a continual effort to translate significant operational factors into cost-effective force management decisions pertaining to maintenance-inspection, timely replacement, and operational readiness. A.T.

A79-44458 **Evaluation of a crack-growth gage for monitoring possible structural fatigue-crack growth.** N. E. Ashbaugh (Systems Research Laboratories, Inc., Dayton, Ohio) and A. F. Grandt, Jr. (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio). In: Service fatigue loads monitoring, simulation, and analysis; Proceedings of the Symposium, Atlanta, Ga., November 14-15, 1977. Philadelphia, Pa., American Society for Testing and Materials, 1979, p. 94-117. 18 refs.

The use of a precracked coupon for monitoring the effect of structural loads upon fatigue crack growth is presented. The coupon or 'gage' provides a convenient means for determining crack growth since crack extension in the gage is a result of loads on the structure which cause the damage. Experimental results are reported for gages made from two aluminum alloys with two types of crack geometries, a center crack and a crack at the edge of a hole. The effect of load amplitude upon crack growth in the gage as a function of the crack growth in the structure was investigated using constant amplitude cyclic load. A theoretical model was developed to predict the correlation between the growth of cracks in the gage and the structure, and the load transfer from the structure through the ends of the gage and the crack-propagation law for the crack growth in the gage and the structure were important factors in the analysis. A.T.

A79-44459 **Flight spectra development for fighter aircraft.** N. H. Sandlin, R. R. Lauridia, and D. J. White (Vought Corp., Dallas, Tex.). In: Service fatigue loads monitoring, simulation, and analysis; Proceedings of the Symposium, Atlanta, Ga., November 14-15, 1977. Philadelphia, Pa., American Society for Testing and Materials, 1979, p. 144-157. 6 refs.

A method is presented for deriving realistic flight-by-flight stress spectra which are valid for any point in the structure of fighter or attack type aircraft. This method uses regression equations to define the relationships among stresses and flight parameters. The statistical distributions of aircraft motion parameters are derived and defined in multi-parameter response tables. These tables are combined with assigned mission profile data to establish all of the required flight parameters which are used in the regression equations to develop stress spectra. These spectra then are sequenced into a flight-by-flight order which can be used as input to a damage determination model or as a load program for laboratory testing. (Author)

A79-44460 **Flight-by-flight spectrum development.** A. G. Denyer (Rockwell International Corp., El Segundo, Calif.). In: Service fatigue loads monitoring, simulation, and analysis; Proceedings of the Symposium, Atlanta, Ga., November 14-15, 1977. Philadelphia, Pa., American Society for Testing and Materials, 1979, p. 158-175. 5 refs.

A method of developing the design flight-by-flight sequenced stress spectrum at any location within the primary airframe structure is presented. The procedure commences with the applicable procurement specifications for the aircraft and concludes with the detail's local stress spectrum suitable for fatigue and fracture mechanics analyses or testing. The stress spectrum is created within a computer program that utilizes input data comprising mission profiles, structural location data, libraries of load factor exceedance data, balanced external load conditions, and corresponding internal loads solutions. The output consists of the spectrum in tabular form and the time trace graphs of the stress amplitude. Included is a typical spectrum developed for a variable geometry bomber with terrain-following capability, and discussion as to load sequence effects and the structural internal loads solutions necessary to describe the stress trace on a mission-by-mission basis. Finally, the system-generated spectrum is discussed in terms of its effect on fatigue and fracture mechanics analysis. (Author)

A79-44461 **Methods of gust spectra prediction for fatigue damage.** W. W. Wilson and J. E. Garrett (Lockheed-Georgia Co., Marietta, Ga.). In: Service fatigue loads monitoring, simulation, and analysis; Proceedings of the Symposium, Atlanta, Ga., November 14-15, 1977. Philadelphia, Pa., American Society for Testing and Materials, 1979, p. 176-192. 7 refs. Contract No. F33657-76-D-0873.

The prediction of aircraft responses to atmospheric turbulence using a general exponential gust exceedance equation is based on the assumption that altitude dependent spectra curve fit parameters contained in the exceedance equation are representative of the atmosphere and thus equally applicable to accelerations, loads, stresses, etc. Using vertical acceleration gust data recorded during fleet operations of the USAF C-5A transport aircraft, altitude dependent curve fit parameters were developed; these parameters were then shown to accurately predict the recorded wing stress gust experience at three wing locations, thus supporting the assumption of their uniformity between response parameters. This gust analysis then was substantiated with a second, independent analysis in which the recorded vertical acceleration gust data were converted directly to stress spectra by means of analytical stress to acceleration ratios. (Author)

A79-44462 **Derivation of flight-by-flight spectra for fighter aircraft.** M. P. Kaplan, J. A. Reiman, and M. A. Landy (USAF, Structures Div., Wright-Patterson AFB, Ohio). In: Service fatigue loads monitoring, simulation, and analysis; Proceedings of the Symposium, Atlanta, Ga., November 14-15, 1977. Philadelphia, Pa., American Society for Testing and Materials, 1979, p. 193-207.

Methods of obtaining the usage data and developing a flight-by-flight spectrum for a ground attack fighter in the design phase and for an existing aircraft that has undergone a change in usage are presented. The importance of predicting the durability and damage tolerance capability of aircraft structures emphasized the need for a realistic flight-by-flight stress spectrum. This stress spectrum is generated from an analysis of the projected mission profiles, combined with load factor exceedance curves obtained from military specifications or recorded data. Using either exceedance curve approach, these data are combined with the mission profile data to develop a stress-exceedance curve for each mission. The mission profiles contain information on mission length, number of times flown per lifetime, fuel load, and weapons configuration. The final result is a random flight-by-flight stress spectra suitable for performing damage tolerance and durability analyses and tests. A.T.

A79-44463 **Test simulation of fighter aircraft maneuver load spectra.** L. L. Jeans and W. L. Tribble (Northrop Corp., Hawthorne, Calif.). In: Service fatigue loads monitoring, simulation, and analysis; Proceedings of the Symposium, Atlanta, Ga., November 14-15, 1977. Philadelphia, Pa., American Society for Testing and Materials, 1979, p. 240-254. 5 refs. Contract No. F33615-75-C-5236.

The use of power spectral density (PSD) and related laboratory random data analysis techniques to characterize low frequency loading spectra output response, measured from a specimen, for comparing test machine responses is studied. A digital technique simulating aircraft maneuver spectrum loading in the time domain is used to generate the input load spectrum signal to an electro-hydraulic closed-loop test machine for fatigue testing of graphite-epoxy to titanium joints at various frequencies and PSD shapes. The output signal measured from the specimen was processed to determine the PSD response and root mean square history, and these data were compared with the recorded strain amplitude history and the input load amplitude, frequency, and PSD information. A qualitative correlation was found between specimen fatigue life, output signal waveform and amplitude, and variations in PSD, and it was concluded that the way a fatigue test machine processes an input load and frequency signal can affect the measured fatigue life of certain materials. A.T.

A79-44794 # **Computer aided design of mixed flow turbines for turbochargers.** N. C. Baines, F. J. Wallace, and A. Whitfield (Bath, University, Bath, England). *(American Society of Mechanical Engineers, Gas Turbine Conference, London, England, Apr. 9-13, 1978, Paper 78-GT-191.) ASME, Transactions, Journal of Engineering for Power,* vol. 101, July 1979, p. 440-448; Discussion, p. 448, 449; Authors' Closure, p. 449. 16 refs. Research supported by the Science Research Council and Holset Engineering Co.

The paper describes a comprehensive computer aided design procedure and its use to investigate mixed flow turbines for automotive turbocharger applications. The outside dimensions of rotor and casing as well as blade angles are determined from one-dimensional design and off design calculations, the detailed blade shape from quasi-three-dimensional analysis and mechanical stressing and vibration programs, and geometric data are presented as outside views and sections of the rotor by a graphics subroutine. The procedure consists of a series of separate programs rather than a single program, so that the designer's intervention at each stage of the process can be applied. Two mixed flow rotors were designed, manufactured and tested in a specially designed high speed dynamometer. The first was intended to achieve a substantial increase in mass flow over the reference radial rotor without loss of efficiency, while the latter was intended as a direct replacement of the reference radial rotor, but should give more favorable pulse performance when operating in conjunction with an engine due to changes in the operating map viz: a) lower tip speeds for best efficiency, and b) flatter mass flow characteristics. Both effects were predicted by analysis and confirmed by tests. (Author)

A79-44800 # **Propulsion system and airframe integration consideration for advanced air-to-surface aircraft.** R. J. May (USAF, Aero Propulsion Laboratory, Wright-Patterson, AFB, Ohio) and G. K. Richey (USAF, Flight Dynamics Laboratory, Wright-Patterson, AFB, Ohio). *AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1120.* 13 p.

Important propulsion system and airframe integration considerations for cost-effective advanced air-to-surface aircraft, resulting from an analytical program employing data from six airframe and three engine manufacturers, are discussed. The analysis indicates that engine costs will account for nearly 30% of the system development cost, 23% of production cost, and 37% of the operation and support cost for the system. An advanced technology engine will be required to meet mission requirements and minimize system life cycle costs for an advanced strike fighter. A simple, single spool, fixed geometry turbine turbojet engine is an attractive candidate. Reduced radar cross section, low inlet weight and reduced subsonic and supersonic drag are factors which must be considered in an air to surface design. The use of 2-D nozzles for TCS/IR control, maneuverability enhancement and STOL flexibility will be primary considerations in air-to-surface vehicle applications. C.K.D.

A79-44874 **The influence of turbulence on drag.** W. H. Bell (Institute of Ocean Sciences, Patricia Bay, British Columbia, Canada). *Ocean Engineering,* vol. 6, no. 3, 1979, p. 329-340. 19 refs.

The use of the Reynolds number as the only correlating factor for drag force measurements may be inadequate in circumstances involving highly turbulent flows. The results of previous investigations relating to the effects of turbulence scale and intensity are examined. Of special interest is the possibility of a drag minimum, even at low Reynolds number, for a free-stream turbulence intensity of about 5%. This appears to be the result of interaction between the free stream and the boundary layer. As intensity increases beyond 5%, the minimum may be succeeded by an increase in drag to values exceeding the laminar flow values. Further elucidation of the subject is required, particularly because of its importance in various problems related to geophysical flows. (Author)

A79-44878 # **Extremal radio-navigation (Ekstremal'naia radionavigatsiia).** V. I. Alekseev, A. M. Korikov, R. I. Polonnikov, and V. P. Tarasenko. Moscow, Izdatel'stvo Nauka, 1978. 280 p. 149 refs. In Russian.

The book presents design approaches and a basic theory of automatic navigation systems based on the use of extremal control principles and statistically optimal radio-navigation signal processing procedures. Adaptive models, optimization algorithms, first-order difference-measuring systems, and second-order angle- and difference-measuring systems are considered together with the principles of partial synthesis of long-range radio-navigation systems, optimization model adaptation, accuracy and noise immunity optimizations, and coordinate determination. Attention is given to models of radio channels, instabilities of on-board master oscillators, signal sources, and navigation spaces. Possibilities of applying the extremal principles of radio-navigation to satellite signal processing are evaluated. V.T.

A79-44884 # **Aircraft instrument components /3rd revised and enlarged edition/ (Detali aviatsionnykh priborov /3rd revised and enlarged edition/).** B. A. Ass, E. F. Antipov, and N. M. Zhukova. Moscow, Izdatel'stvo Mashinostroenie, 1979. 232 p. 68 refs. In Russian.

Theoretical, operational, design and calculational aspects of typical aircraft instrument components are presented. Components considered include cylindrical, spherical, prismatic, elastic, air and ball bearings, and transmission mechanisms, including gears, levers, stopping mechanisms and clutches. Elastic and inertial sensors, including springs, membranes and Sylphon bellows, parametric transducers, including potentiometers, strain resistors, thermoresistors, capacitance and inductance sensors and photosensitive elements, generating sensors, including thermoelectric, induction, peizoelectric and barrier-layer cell devices, and magnetoelectric, electromagnetic and electrodynamic sensors are discussed. Attention is also given to gyromotors, dampers, shock absorbers, electrical contacts, indicators and housings. A.L.W.

A79-44892 # **Aircraft antenna systems (Samoletnye antennye sistemy).** Iu. G. Shatrakov, M. I. Rivkin, and B. G. Tsybaev. Moscow, Izdatel'stvo Mashinostroenie, 1979. 184 p. 67 refs. In Russian.

Factors affecting the design of aerial feeders are discussed. The characteristics and principles of operation of different types of aerial antenna-feeder systems are reviewed, and the interaction of the elements of these systems with aircraft components is examined. Theoretical methods used in design development to assess the performance of systems and system components are considered. Systems using dipole antennas, slot antennas, driven antennas, hybrid antennas, and leaky antennas are described, and test methods are presented. C.K.D.

A79-44893 # **Assembly and testing of flight-vehicle hydraulic and pneumatic systems /2nd enlarged and revised edition/ (Montazh i ispytanie gidravlicheskikh i pnevmaticheskikh sistem letatel'nykh apparatov /2nd enlarged and revised edition/).** V. M. Sapozhnikov. Moscow, Izdatel'stvo Mashinostroenie, 1979. 256 p. 37 refs. In Russian.

Theoretical and experimental results on the design and operational testing of aircraft hydraulic, pneumatic and fuel systems are discussed. Consideration is given to (1) determination of stress-strain states during assembly, (2) techniques for cleaning such systems, (3) quality control techniques, (4) ways to assure hermetic conditions, and (5) performance testing techniques. B.J.

A79-44894 # **Handbook of flight communication and radio equipment (Spravochnik po sviazi i radiotekhnicheskomu obespecheniiu poletov).** Iu. I. Dukhon, N. N. Il'inskii, and G. I. Laushev. Moscow, Voenizdat, 1979, 287 p. 19 refs. In Russian.

The book supplies reference data on the choice, design, and installation of aircraft communication and radio systems. Sections are devoted to the effect of the atmosphere on flight communications, climatic effects on radio equipment, organization of radio equipment repairs, safety measures during radio operation, measurement devices and methods related to radio systems, noise protection, electromagnetic compatibility, and a summary of all the tactical parameters of onboard radio equipment. P.T.H.

A79-44953 # **The temperature at which thermal dissociation is initiated in jet fuels under static conditions (Temperatura nachala termicheskogo razlozheniia reaktivnykh topliv v staticheskikh usloviiakh).** A. K. Bukharkin and G. I. Kovalev. *Khimiia i Tekhnologiia Topliv i Masel,* no. 7, 1979, p. 16-18. In Russian.

The temperature at which thermal dissociation is initiated in jet fuels was investigated by means of an instrumented autoclave installation. Fuels were heated to temperatures ranging from 300 to 425 C for a period of 240 min. Little gas evolution was observed from the fuels studied over the interval 300-380 C. However, the amount of gas evolved sharply increased at temperatures above 400 C, accompanied by changes in iodine value. The rate of cracking was found to decrease with time. The observed temperatures at which dissociation was initiated were in good agreement with results predicted by kinetic theory. C.K.D.

A79-45067 **Application of hot isostatic pressing to aircraft gas turbines.** D. J. Evans (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn.). In: High-pressure science and technology; Proceedings of the Sixth International Conference, Boulder, Colo., July 25-29, 1977. Volume 2. New York, Plenum Press, 1979, p. 656-663. 8 refs.

Background, equipment, and applications of hot isostatic pressing (HIP) of gas turbine components are reviewed. HIP equipment using pressures up to 30,000 psi and various heating methods is described. HIP powder consolidation was used to make nickel-base superalloy turbine disks and titanium alloy compressor disks, achieving material and cost savings and improved mechanical properties. Densification of structural and rotor castings to minimize porosity and segregation and improve mechanical properties was accomplished with HIP. This process is also used to improve the quality of turbine airfoil and hot-section case castings. Future uses of HIP in processing superalloy powders will include the fabrication of hybrid structures-components requiring two different levels of mechanical properties. A.T.

A79-45249 **Disaggregate mode-share models for air freight policy analysis.** L. B. Wilson (Atchison Topeka and Santa Fe Railway Co., Chicago, Ill.) and N. K. Taneja (MIT, Cambridge, Mass.). *Transportation Research,* vol. 13A, Apr. 1979, p. 115-123. 22 refs.

This paper describes the modification and extension of a new disaggregate simulation freight demand model, developed at MIT center for Transportation Studies, for analysis of air cargo. This model system, utilizing existing published data, develops estimates of modal shares for individual commodity groups in any specified U.S. domestic city pair market. Firms are assumed to minimize 'total logistics cost' in making modal choice decisions. Individual results are accumulated and modal share estimates developed which can then be used in preparing aggregate forecasts of modal flows. The study clearly demonstrates the feasibility of extending this demand model to include analysis of air cargo. The model system is applied to the Houston-Chicago and Los Angeles-Boston market pairs, with encouraging empirical results: the model share estimates are quite plausible when compared with existing flow information. (Author)

A79-45250 **Review of aircraft bearing rejection criteria and causes.** J. S. Cunningham, Jr. and M. A. Morgan (U.S. Navy, Naval Air Rework Facility, Cherry Point, N.C.). *Lubrication Engineering,* vol. 35, Aug. 1979, p. 435-441.

This paper presents the results of an aircraft ball and roller bearing rejection analysis undertaken at the Naval Air Rework Facility, Cherry Point, North Carolina. Data utilized in this analysis was derived from three 80-day engineering samples taken during 1969, 1971 and 1977. Actual numerical and statistical failure data pertaining to corrosion, pitting, wear, fatigue, etc. are discused and overall conclusions are drawn concerning earth rejection category. The results of this analysis should provide a base for studies of the economics of bearing reprocessing and aid in identifying those areas where developmental work can provide the most significant increases in bearing life and dependability. (Author)

A79-45258 * # Numerical solution for the flow field of a body with jet. N.-S. Liu (Joint Institute for Advancement of Flight Sciences, Hampton, Va.). In: Computational Fluid Dynamics Conference, Williamsburg, Va., July 23-25, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 66-73. 16 refs. Grant No. NGR-09-010-085. (AIAA 79-1452)

This paper presents a method of computing the laminar flow field of a body with stern-mounted jet. Problems involved are the numerical solutions of boundary layer and Navier-Stokes equations as well as the viscous-inviscid interaction. The adequacy of a simple viscous-inviscid interaction approach is investigated and a technique for connecting hybrid mesh systems without overlapping of meshes is presented. The numerical results indicate that while the external wake flow affects the development of the jet flow, the presence of a jet also influences the flow in the stern region of the body. (Author)

A79-45261 * # A fast, conservative algorithm for solving the transonic full-potential equation. T. L. Holst (NASA, Ames Research Center, Applied Computational Aerodynamics Branch, Moffett Field, Calif.). In: Computational Fluid Dynamics Conference, Williamsburg, Va., July 23-25, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 109-121. 23 refs. (AIAA 79-1456)

A fast, fully implicit approximate factorization (AF) algorithm designed to solve the conservative transonic full-potential equation in either two or three dimensions is described. The algorithm uses an upwind bias of the density coefficient for stability in supersonic regions. This provides an effective upwind difference of the streamwise terms for any orientation of the velocity vector (i.e., 'rotated differencing'), and thereby greatly enhances the reliability of the present algorithm. A numerical transformation is used to establish an arbitrary body-fitted finite-difference mesh. Computed results for both airfoils and simplified wings demonstrate substantial improvement in convergence speed for the new algorithm relative to standard successive-line overrelaxation algorithms. (Author)

A79-45265 # Three-dimensional coordinates about wings. P. R. Eiseman. In: Computational Fluid Dynamics Conference, Williamsburg, Va., July 23-25, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 166-174. 6 refs. (AIAA 79-1461)

The three-dimensional problem of mesh generation about airplane wings is studied with the development of a coordinate transformation. Salient features of the coordinates are that arbitrarily shaped wings can be specified, that coordinate distributions along the wing surface can be specified, that coordinate angles leaving the wing surface can be specified, that the distribution of coordinate surfaces surrounding the wing can be specified, and that the coordinates can be smoothly joined with a surrounding spherical coordinate system for a far field analysis. When a far field spherical coordinate system is desired, there is, however, a constraint on the mesh topology which would otherwise be absent. From the viewpoint of computational economy, the coordinates can be generated quickly and with little storage since the basic constructive process consists of a short sequence of two-dimensional constructions. Moreover, when the spherical mesh topology is desired, the coordinates can be given in an analytically defined form so that any mesh point may be obtained directly and with a negligible amount of storage. (Author)

A79-45269 * # A two-dimensional unsteady Euler-equation solver for flow regions with arbitrary boundaries. R. G. Hindman (NASA, Ames Research Center, Moffett Field, Calif.; Iowa State University of Science and Technology, Ames, Iowa), P. Kutler (NASA, Ames Research Center, Computational Fluid Dynamics Branch, Moffett Field, Calif.), and D. Anderson (Iowa State University of Science and Technology, Ames, Iowa). In: Computational Fluid Dynamics Conference, Williamsburg, Va., July 23-25, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 204-217. 39 refs. Research supported by Iowa State University of Science and Technology and NASA. (AIAA 79-1465)

A new technique is described for solving supersonic fluid dynamic problems containing multiple regions of continuous flow, each bounded by a permeable or impermeable surface. Region boundaries are, in general, arbitrarily shaped and time dependent. Discretization of such a region for solution by conventional finite difference procedures is accomplished using an elliptic solver which alleviates the dependence on a particular base coordinate system. Multiple regions are coupled together through the boundary conditions. The technique has been applied to a variety of problems including the shock diffraction and pointed wedge with detached bow shock. (Author)

A79-45273 * # Vector processor algorithms for transonic flow calculations. J. C. South, Jr., J. D. Keller (NASA, Langley Research Center, Hampton, Va.), and M. M. Hafez (Flow Research Co., Kent, Wash.). In: Computational Fluid Dynamics Conference, Williamsburg, Va., July 23-25, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 247-255. 13 refs. (AIAA 79-1457)

This paper discusses a number of algorithms for solving the transonic full-potential equation in conservative form on a vector computer, such as the CDC STAR-100 or the CRAY-1. Recent research with the 'artificial density' method for transonics has led to development of some new iteration schemes which take advantage of vector-computer architecture without suffering significant loss of convergence rate. Several of these more promising schemes are described and 2-D and 3-D results are shown comparing the computational rates on the STAR and CRAY vector computers, and the CYBER-175 serial computer. Schemes included are: (1) Checkerboard SOR, (2) Checkerboard Leapfrog, (3) odd-even vertical line SOR, and (4) odd-even horizontal line SOR. (Author)

A79-45302 Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. Conference sponsored by the American Institute of Aeronautics and Astronautics. New York, American Institute of Aeronautics and Astronautics, Inc., 1979. 489 p. $35.

A group of papers discussing various aspects of flight mechanics applicable to future space systems is presented. Theoretical models and experimental techniques for predicting and testing the aerodynamic performance of air- and spacecraft are considered, together with control system hardware and software. General topics include aerodynamics, aircraft handling and flight qualities, flight mechanics, parameter estimation, unsteady aerodynamics, and computer systems. C.K.D.

A79-45303 * # Singular perturbation techniques for on-line optimal flight path control. A. J. Calise (Drexel University, Philadelphia, Pa.). In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 1-8. 9 refs. Grant No. NsG-1496. (AIAA 79-1620)

This paper presents a partial evaluation on the use of singular perturbation methods for developing computer algorithms for on-line optimal control of aircraft. The evaluation is based on a study of the minimum time intercept problem using F-4 aerodynamic and propulsion data as a base line. The extensions over previous work on this subject are that aircraft turning dynamics (in addition to position and energy dynamics) are included in the analysis, the algorithm is developed for a moving end point and is adaptive to unpredictable target maneuvers, and short range maneuvers that do not have a cruise leg are included. Particular attention is given to identifying those quantities that can be precomputed and stored (as a function of aircraft total energy), thus greatly reducing the onboard computational load. Numerical results are given that illustrate the nature of the optimal intercept flight paths, and an estimate is given for the execution time and storage requirements of the control algorithm. (Author)

A79-45304 # **The extremal trajectory map - A new representation of combat capability.** N. Rajan (Indian Space Research Organization, Satellite Centre, Bangalore, India) and U. R. Prasad. In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 9-12. 13 refs. (AIAA 79-1622)

Aircraft pursuit-evasion in three dimensions is formulated as a differential game with five state variables. The aircraft are modeled in energy. A suitable choice of real space coordinates confers open-loop optimality on the game. Its parties can be pieced together using the individual aircraft's energy extremal maps (EEM). An EEM consists of a stack of constant altitude extremal trajectory maps; it is essentially a family of single aircraft minimum time maneuvers. It represents the pursuit-evasion capability of the aircraft independent of adversary, role and capture radius and is hence an effective tool for design. (Author)

A79-45305 # **Approximate trajectory solutions for fighter aircraft.** L. E. Miller (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 13-20. (AIAA 79-1623)

Approximate solutions to the segments of typical fighter trajectory profiles are obtained. The specific problems addressed are subsonic cruise, supersonic cruise, initial climb, and supersonic acceleration and climb. Closed form solutions for the initial climb problem are in good agreement with the results obtained from the integration of the differential equations of state. The agreement is not as good for the supersonic acceleration and climb. Theoretical subsonic cruise range factor performance results agree quite well with the actual optimum results. For the supersonic cruise problem, it is demonstrated that universal distributions between fuel flow and thrust could be developed that are independent of altitude. Thus minimum fuel flow or maximum range factor can be easily determined. The utility of the solutions is that relationships between performance and system characteristics are developed. The solutions do not depend upon the details of the variation in the parameters along the path but only on the conditions at the ends of the path or average values. (Author)

A79-45306 # **Numerical computation of optimal evasive maneuvers for a realistically modeled airplane pursued by a missile with proportional guidance.** C. Hargraves, F. Johnson, S. Paris, and I. Rettie (Boeing Aerospace Co., Seattle, Wash.). In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 21-31. 12 refs. (AIAA 79-1624)

A second order, direct trajectory optimization method in which the state time history is described by Chebyshev polynomials and the dynamical equations are satisfied by penalty functions is described. The convergence and fidelity of the method are demonstrated with solutions to the following problems: brachistochrone, Goddard rocket problem with a singular arc, supersonic interceptor minimum time climb, subsonic transport minimum time climb, supersonic glider maximum range, subsonic transport minimum fuel for a fixed range mission including climb, cruise and descent. The method is then applied to the computation of optimal evasive maneuvers for an airplane pursued by a missile with proportional guidance. The results demonstrate that the method provides an efficient and reliable procedure for solving a wide variety of trajectory optimization problems. (Author)

A79-45307 * # **Application of the equilibrium spin technique to a typical low-wing general aviation design.** M. B. Tischler and J. B. Barlow (Maryland, University, College Park, Md.). In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 32-42. 19 refs. Research supported by the Minta Martin Fund for Aeronautical Research; Grant No. NsG-1570. (AIAA 79-1625)

A graphical implementation of the equilibrium technique for obtaining spin modes from rotary balance data is presented. Using this technique, spin modes were computed for the NASA Low-Wing General Aviation Aircraft. The computed angles of attack are within 10 degrees of the NASA spin tunnel results. The method also provides information on the dynamic nature of spin modes. This technique offers the capability of providing a great deal of information on spin modes and recovery, using data from a single experimental installation. Such a technique could be utilized in the preliminary design phase in order to provide basic information on aircraft spin and recovery characteristics. Results, advantages and limitations of the application of this technique are discussed. (Author)

A79-45312 # **Unsteady wing boundary layer energization.** H. Viets, M. Ball (Wright State University, Dayton, Ohio), and M. Piatt. In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 79-83. 15 refs. Grant No. AF-AFOSR-78-3525. (AIAA 79-1631)

A rotor mounted in the surface of a symmetrical airfoil section is employed to generate vortices in conjunction with the flow over the airfoil. The vortices are swept over the upper surface of the airfoil. For separated flow over the airfoil at high angles of attack, the rotor is shown to reduce the size of the separated region and in addition reduce the pressure on the upper airfoil surface. The vortices produced by the rotor appear to energize the boundary layer by bringing higher energy flow from the main stream to the wall region. (Author)

A79-45313 # **Transonic flutter analysis of a rectangular wing with conventional airfoil sections.** F. E. Eastep and J. J. Olsen (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 84-92. 14 refs. (AIAA 79-1632)

Flutter analysts have encountered considerable analytical difficulties in the prediction of the flutter stability of aircraft operating in the transonic Mach number regime. Because of the shocks and nonlinearities of transonic flow the aerodynamic unsteady forces have been difficult to determine and have prohibited accurate determination of the flutter speed. The finite-difference relaxation method is used to determine the oscillatory transonic aerodynamic forces on a uniformly stiff cantilever rectangular wing in a flow field with mixed subsonic and supersonic regions together with shock waves. The flutter speed is determined at two transonic Mach numbers and is compared to the flutter speed obtained using a linear aerodynamic theory. (Author)

A79-45314 * # **Application of two synthesis methods for active flutter suppression on an aeroelastic wind tunnel model.** I. Abel, J. R. Newsom, and H. J. Dunn (NASA, Langley Research Center, Hampton, Va.). In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 93-103. 14 refs. (AIAA 79-1633)

Two flutter suppression control laws have been synthesized, implemented, and demonstrated on an aeroelastic wind-tunnel model of a transport-type wing. One control law was synthesized using an aerodynamic energy method and the other from using results of optimal control theory. At M = 0.95, the model was tested to a dynamic pressure 44 percent above the system-off flutter dynamic pressure. Both synthesis methods yielded control laws effective in suppressing flutter. The experimental results also indicate that wind-tunnel turbulence is an important factor in the experimental demonstration of system performance. (Author)

A79-45316 # **Parallel procedures for aircraft parameter identification and state estimation.** R. Travassos and H. Kaufman (Rensselaer Polytechnic Institute, Troy, N.Y.). In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 111-119. 14 refs. Grant No. AF-AFOSR-77-3418. (AIAA 79-1636)

Parallel algorithms for simultaneously estimating the state and identifying the parameters of a noisy nonlinear dynamic system without using linearization are presented. The state and parameters (SAP) estimating procedures, including parallel shooting, which are applicable to a wide class of nonlinear estimation problems are discussed. Parallel methods for minimization and a parallel method for integrating ordinary differential equations are presented, along with a parallel algorithm execution time estimation. The performance of these methods is demonstrated by simultaneously estimating the state and identifying the aerodynamic parameters which define the equations of motion for a T-33 aircraft. Results indicate that convergence to the true values of the state and parameters can occur even if poor estimates of these values are made initially. V.T.

A79-45317 # **Aerodynamic data development for the turboprop T-44A Operational Flight Trainer.** R. A. Curnutt (Beech Aircraft Corp., Wichita, Kan.). In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 120-128. 6 refs. (AIAA 79-1637)

A comprehensive program has been conducted to develop aerodynamic data for the Navy/Beech T-44A Operational Flight Trainer (OFT) - a full-mission flight training simulator. This program, which considerably expanded the aerodynamic data base in order to satisfy OFT full-flight-envelope fidelity requirements, included special flight and ground tests, inertia measurements, wind tunnel tests, a parameter identification program and an extensive data-matching effort. The paper describes the various facets of the program, discusses the sequence followed in data matching, and offers some comparisons between estimated, wind tunnel, parameter identification and 'final' data used in the OFT. (Author)

A79-45318 * # **A model for unsteady effects in lateral dynamics for use in parameter estimation.** W. R. Wells (Wright State University, Dayton, Ohio), S. S. Banda, and D. L. Quam (Dayton, University, Dayton, Ohio). In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 129-134. 10 refs. Grant No. NsG-1417. (AIAA 79-1638)

A mathematical model for the unsteady aerodynamic effects for use in lateral aircraft dynamics has been developed. The approach is to derive approximations to the force and moment coefficients based on Weissinger's arrangement for the trailing vortex pattern for a sideslipped wing. The main thrust of the modeling is for application to estimation of the lateral stability and control derivatives. (Author)

A79-45319 * # **The relationship of unsteadiness in downwash to the quality of parameter estimates.** W. R. Wells (Wright State University, Dayton, Ohio) and D. A. Keskar (SDC Integrated Services, Inc., Hampton, Va.). In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 135-142. 9 refs. Grant No. NsG-1417. (AIAA 79-1639)

This paper investigates the relative importance of including unsteady effects in the lift and downwash in the longitudinal dynamics and parameter extraction algorithm. A simple vortex system has been used to model unsteady aerodynamic effects into the longitudinal equations of motion of an aircraft. Computer-generated data and flight data were used to demonstrate that inclusion of unsteady aerodynamics in the parameter-extraction algorithm produced aerodynamic parameters that were different from those extracted when unsteady aerodynamics were left out of the algorithm. The differences between derivatives associated with the two extraction algorithms (with and without unsteady aerodynamics) were related to acceleration derivatives which usually cannot be extracted individually. (Author)

A79-45320 # **Impact of digital computer technology on flight systems.** T. B. Smith (Charles Stark Draper Laboratory, Inc., Cambridge, Mass.). In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 143-146. 6 refs. (AIAA 79-1641)

The impact of new applications of digital computer technology, particularly microcomputer technology, on flight systems are discussed. While reducing size and cost and increasing accuracy and reliability, this new technology will require matching technology advances in structure, aerodynamics, and control. The changes in the design of future aircraft will be more evolutionary than revolutionary. Different advantages of digital computer technology, such as quieter and more fuel efficient engines, reduction of the risk of pilot error in unusual contingency situations, and reduction of the wiring weight and complexity in an aircraft are presented. V.T.

A79-45325 * # **Water tunnel visualization of the vortex flows of the F-15.** D. J. Lorincz (Northrop Corp., Hawthorne, Calif.) and E. L. Friend (NASA, Flight Research Center, Stability and Control Branch, Edwards, Calif.). In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 194-208. 14 refs. Contract No. NAS4-2526. (AIAA 79-1649)

Flow visualization studies were conducted in a diagnostic water tunnel to provide details of the wing, glove, and forebody vortex flow fields of the F-15 aircraft over a range of angles of attack and sideslip. Both the formation and breakdown of the vortex flow as a function of angle of attack and sideslip are detailed for the basic aircraft configuration. Additional tests showed that the wing upper surface vortex flows were sensitive to variations in an inlet mass flow ratio and an inlet cowl deflection angle. Two lengthened forebodies, one with a modified cross-sectional shape, were tested in addition to the basic forebody. Asymmetric forebody vortices were observed at zero sideslip and high angles of attack on each forebody. A large nose boom was added to each of the three forebodies, and it was observed that the turbulent wake shed from the boom disrupted the forebody vortices. V.T.

A79-45326 # **Goniometric aerodynamics: A different perspective: Description - Applications.** R. Lecat and J. Rietschlin (Grumman Aerospace Corp., Bethpage, N.Y.). In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 209-223. 6 refs. (AIAA 79-1650)

Good correlations have been obtained on A/C and missile configurations and their components with Polhamus potential lift constant and vortex lift constant formulations and approximations for suction orientation, edge bluntness, etc. All geometries are reduced to two angles: semispan diagonal sweep angle and the orientation of the total suction. A modification of the Polhamus potential lift constant formula gives good correlations across the Mach number range, using aspect ratio transformations. When M is greater than 1, the apparent aspect ratio increases as the Mach cone cuts the corners of the rectangular reference area, until it becomes a triangle when 1/M equals the cosine of the semispan diagonal sweep angle. B.J.

A79-45327 # **Aerodynamic development of a small horizontal tail for an active control relaxed stability transport application.** D. M. Urie and J. S. Reaser (Lockheed-California Co., Burbank, Calif.). In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 224-231. 6 refs. (AIAA 79-1653)

Released static stability (RSS) with active control stability augmentation contributes to aircraft efficiency by permitting more aft center of gravity with reduced trim drag and/or by allowing a smaller horizontal tail with less parasite drag and weight. A small tail has been designed for derivative versions of the Lockheed L-1011 using state-of-the-art lifting surface definition methods. Low-speed and transonic wind tunnel data verifying theoretical predictions have been obtained. A minimum size tail for this application was obtained and design details required for maximum performance were identified. A configuration suitable for production has been defined and will be developed through prototype flight testing on an L-1011. (Author)

A79-45328 # **An analysis of operational procedures and design modifications for aircraft fuel conservation.** R. Aggarwal, A. Dushman (Dynamics Research Corp., Wilmington, Mass.), and A. J. Calise (Drexel University, Philadelphia, Pa.). In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 232-242. 11 refs. (AIAA 79-1656)

This paper is taken from a two year study conducted to determine the effectiveness of fuel conservation measures as applied to Air Force bomber/transport type aircraft. The impact of various potential design and operational procedure improvements are quantified. A major contribution of this study is the approach taken to generate the effect of design changes on fuel consumption and direct operating cost (DOC). Sensitivity plots of fuel and DOC savings as a function of the design parameters are generated for each aircraft type. These plots are based on actual mission trajectory data as opposed to 'typical' mission trajectory profiles. (Author)

A79-45330 * # **Effects of spanwise blowing on two fighter airplane configurations.** E. L. Anglin and D. Satran (NASA, Langley Research Center, Hampton, Va.). In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 286-294. 9 refs. (AIAA 79-1663)

The NASA Langley Research Center has recently conducted an investigation to determine the effects of spanwise blowing on two configurations representative of current fighter airplanes. This research examined not only the longitudinal, or performance, effects but was especially oriented toward determining the lateral-directional effects, particularly in the stall/departure angle of attack range. The wind tunnel tests included measurement of static and forced-oscillation aerodynamic data, visualization of the airflow changes over the wing created by the spanwise blowing and free flight model tests. Effects of blowing rate, chordwise location of the blowing ports, asymmetric blowing, and the effects of blowing on the effectiveness of conventional aerodynamic controls were investigated. (Author)

A79-45333 * # **Computation of subsonic and transonic flow about lifting rotor blades.** R. Arieli and M. E. Tauber (NASA, Ames Research Center, Moffett Field, Calif.). In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 314-323. 9 refs. (AIAA 79-1667)

An inviscid, nonconservative, three-dimensional potential flow code has been developed for computing the quasi-steady flow about an isolated lifting rotor blade. Calculations from the code were compared with chordwise pressure measurements obtained in a wind tunnel on a nonlifting rotor at transonic tip speeds at advance ratios from 0.40 to 0.55. The overall agreement between theoretical calculations and experiment was good. To illustrate the early capability of the program, the flow about a hypothetical lifting rotor blade having twist, airfoil thickness taper, and a 20 deg sweptback tip was analyzed at azimuthal positions of 60, 90, and 120 deg for an advance ratio of 0.342. A typical run on a CDC 7600 computer required about 5 min for one rotor position at transonic tip speeds. (Author)

A79-45339 * # **Gust alleviation using direct turbulence measurements.** E. G. Rynaski, D. Andrisani, II, and B. J. Eulrich (Calspan Advanced Technology Center, Buffalo, N.Y.). In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 379-386. 6 refs. NASA-supported research; Contract No. F33615-73-C-3051. (AIAA 79-1674)

The research reported upon in this paper describes an effective method of gust alleviation using direct measurements of atmospheric turbulence to drive the aircraft control surfaces in a way that attempts to directly counter or cancel those forces and moments produced on the aircraft by gusts. The method yields a feedforward or open loop control law, simple to mechanize and relatively insensitive to changes in flight condition. When applied directly, the resulting control law effectively gust-alleviates in the low frequency phugoid and short period range but has a tendency to amplify structural mode vehicle motions due to the phase lag of the actuators. A method of design based upon the use of a diagonal or Jordan form of the equations of motion enables the designer to avoid this problem of structural mode excitation. (Author)

A79-45340 * # **Gust alleviation - Criteria and control laws.** E. G. Rynaski (Calspan Advanced Technology Center, Buffalo, N.Y.). In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 387-392. 6 refs. NASA-supported research; Contract No. F33615-73-C-3051. (AIAA 79-1676)

The relationships between criteria specified for aircraft gust alleviation and the form of the control laws that result from the criteria are considered. Open-loop gust alleviation based on the linearized, small perturbation equations of aircraft motion is discussed, and an approximate solution of the open-loop control law is presented for the case in which the number of degrees of freedom of the aircraft exceeds the rank of the control effectiveness matrix. Excessive actuator lag is compensated for by taking into account actuator dynamics in the equations of motion, resulting in the specification of a general load network. Criteria for gust alleviation when output motions are gust alleviated and the closed-loop control law derived from them are examined and linear optimal control law is derived. Comparisons of the control laws reveal that the effectiveness of an open-loop control law is greatest at low aircraft frequencies but deteriorates as the natural frequency of the actuators is approached, while closed-loop methods are found to be more effective at higher frequencies. A.L.W.

A79-45341 * # **Decoupled longitudinal controls for shear penetration in the terminal area environment.** G. K. Miller, Jr. (NASA, Langley Research Center, Hampton, Va.). In: Atmospheric

Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 393-400. 8 refs. (AIAA 79-1678)

The use of decoupled longitudinal controls is simulated for the approach and landing of a twin engine jet transport in the presence of wind shear. Decoupled or independent control of pitch angle, flight-path angle and forward velocity using constant prefilter and feedback gains was compared to conventional control of a B-737 aircraft simulator. It is found that the mean flight-path angle, the mean glideslope error and the mean deviation in indicated airspeed generally improved when decoupled controls were used in the approach. An improvement in touchdown parameters was also observed, especially in strong shear, when 44% of conventionally-controlled flights impacted short of the runway. Simulator pilots reported improved approach performance and a reduced workload when decoupled controls were used. A.L.W.

A79-45342 # **A simulator investigation of roll response requirements for aircraft with rate-command/attitude-hold flight control systems in the landing approach and touchdown.** M. F. C. van Gool and H. A. Mooij (Nationaal Lucht- en Ruimvewaartlaboratorium, Amsterdam, Netherlands). In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 401-410. 17 refs. Research supported by the Rijksluchtvaartdienst. (AIAA 79-1679)

An investigation concerning roll response requirements for aircraft fitted with high-authority augmented flight control systems has been carried out on a moving base flight simulator. Roll response characteristics have been varied in an experiment in which pilots had to carry out instrument approaches in a moderate windshear, followed by a visual segment in which a lateral offset occurred, terminating in a landing with up to 15 knots crosswind. Analyses of pilot commentary and performance measures indicate that the pilot assessment of the flying qualities of the evaluated configurations correlates well with roll response criteria mentioned in the literature for unaugmented aircraft in less demanding tasks. (Author)

A79-45343 # **Effect of reduced visibility on VTOL handling quality and display requirements.** R. H. Hoh and I. L. Ashkenas (System Technology, Inc., Hawthorne, Calif.). In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 411-418. 13 refs. (AIAA 79-1680)

Available data have been used to quantify the intuitive idea that the minimum acceptable handling qualities for low speed and hover are dependent on outside visibility level, augmentation, and cockpit displays. A tentative handling quality criteria format is developed in terms of a visibility scale which quantifies the environmental conditions for the intended mission in a more fine-grained manner than simply specifying IMC or VMC. (Author)

A79-45344 # **Folded shear plane control apparatus for aircraft steering and stabilization.** A. Jones, Jr. In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 419-425. (AIAA 79-1682)

Banking Rudders use folded shear planes as control surfaces to replace the conventional airplane empennage. This new thematic concept does not employ a rudder post or hinged surface, but rather a second order surface deflection generated by the movement of a surface mounted bearing. As more testing is expected to show, the Banking Rudder has potential for the following benefits: (1) reduced parasitic drag, (2) low drag configuration, (3) control force increase, (4) weight reduction, and (5) damage tolerance. (Author)

A79-45345 * # **A review of helicopter control-display requirements for decelarating instrument approach.** J. V. Lebacqz (NASA, Ames Research Center, Moffett Field, Calif.). In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 426-439. 57 refs. (AIAA 79-1683)

This paper reviews research and operational test programs that have dealt with control and display requirements for helicopters performing decelerating approaches in the terminal area under instrument flight conditions. A survey of literature concentrating on flight programs resulted in approximately 50 applicable references which were summarized and classified according to the type of stability/control augmentation that was emphasized. On this basis, display information requirements for each control system type were hypothesized consistent with documented results of these programs. Nine control-display combinations that appear to warrant further ground simulation and flight testing are defined and discussed. (Author)

A79-45346 # **Aerodynamic coefficient estimation by means of an extended Kalman filter.** J. R. Kelsey (Sandia Laboratories, Albuquerque, N. Mex.) and D. P. Petersen (New Mexico, University, Albuquerque, N. Mex.). In: Atmospheric Flight Mechanics Conference for Future Space Systems, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 440-444. Research supported by the U.S. Department of Energy. (AIAA 79-1686)

An extended, augmented Kalman filter is used to study several dynamic models of vehicle motion aimed at estimating the aerodynamic moment coefficients. These models consider various state representations as well as various measurement sets. Linear and cubic symmetric moments are considered as well as linear asymmetric moments. Computer generated data representative of a reentry vehicle flight are used as the simulated measurement information. Coefficient estimates and error estimates are given for each of the models studied. The computer time required for estimate convergence is also shown, indicating that near-real-time estimation is possible. (Author)

A79-45355 # **A multi microprocessor flight control system design principles.** R. E. Pope, J. A. White (Honeywell Systems and Research Center, Minneapolis, Minn.), T. J. Molnar, J. E. May, and S. L. Maher (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 34-39. (AIAA 79-1700)

A multi-microprocessor flight control system (M2FCS) system based on tailoring the architecture to the flight control system application and exploiting the trend toward cheap microelectronic hardware is examined. Flight control system design is comprised of two tasks: the first task is the design of the control laws which must satisfy requirements of stability/control augmentation, direct force control, and automatic modes. The second design task is to transform these control laws into an operational system consisting of flight control sensors, computers, and actuators. The M2FCS system design concentrates on the computer part of this design factors of performance, reliability, maintainability, testability, extensibility, and adaptability, and the design constraints of cost, character of computation, operational environment, power, and packaging. A.T.

A79-45356 # **Dual digital flight control redundancy management system development program.** J. D. Blair and R. D. McCorkle (Boeing Aerospace Co., Seattle, Wash.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 40-46. (AIAA 79-1701)

A dual digital flight control system incorporating interunit selection and redundancy management of device pairs was developed for laboratory demonstration. Four minicomputers connected via dual MIL-STD-1553A data buses perform flight control and input/output functions. The system was interfaced with a piloted flight simulator to provide closed-loop operation. Software was developed for redundancy management of system components and for flight control modes typical of modern transport aircraft. The system was demonstrated by flying simulated mission sequences during which multiple faults were inserted, showing the capability to maintain system integrity in the presence of multiple failures. (Author)

A79-45357 * # **Flight test experience with an adaptive control system using a maximum likelihood parameter estimation technique.** G. Hartmann, G. Stein (Honeywell, Inc., Minneapolis, Minn.), and B. Powers (NASA, Flight Research Center, Edwards AFB, Calif.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 47-53. 5 refs. (AIAA 79-1702)

The flight test performance of an adaptive control system for the F-8 DFBW aircraft is summarized. The adaptive system is based on explicit identification of surface effectiveness parameters which are used for gain scheduling in a command augmentation system. Performance of this control law under various design parameter variations is presented. These include variations in test signal level, sample rate, and identification channel structure. Flight performance closely matches analysis and simulation predictions from previous references. (Author)

A79-45358 * # **Flight test of a VTOL digital autoland system along complex trajectories.** D. R. Downing, W. H. Bryant, and A. J. Ostroff (NASA, Langley Research Center, Flight Electronics Div., Hampton, Va.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 54-63. 8 refs. (AIAA 79-1703)

The objective of this research is the development and flight test of a digital multi-rate VTOL autoland system. This autoland system provided the NASA/Army Fly-by-Wire CH-47 helicopter with an automatic 4-D trajectory following and landing capability. Flight tests were conducted along complex trajectories with descending, turning, and decelerating segments. The flight software consists of a trajectory generator and guidance algorithm operating at two iterations per second and a set of sensor filters and an advanced controller operating at 10 iterations per second. This low iteration rate digital controller has a proportional-integral structure that provides an autotrim function. The control gains, scheduled as a function of flight condition, are updated every two seconds. All flight software, except input/output routines, are coded in FORTRAN using floating point arithmetic and are exercised in a ROLM 1664 flight computer. The flight software, the ground and flight hardware, the autoland system's position tracking performance, and the controller's velocity and heading tracking performance are presented. (Author)

A79-45359 # **The DC-9-80 digital flight guidance system's monitoring techniques.** S. Osder (Sperry Flight Systems, Phoenix, Ariz.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 64-79. 7 refs. (AIAA 79-1704)

The DC-9-80 aircraft is equipped with an integrated digital flight guidance system that provides autopilot, flight director, thrust management, speed control, autothrottle, and stability augmentation within a single computer complex. The present paper describes how the multiplicity of DC-9-80 software and hardware monitors are implemented and how their effectiveness can be analyzed and verified. The system monitors are designed in such a way that fault detection and appropriate shutdown of the failed elements can meet the 10 to the -9th hazard criterion used to certify prior autoland systems. B.J.

A79-45360 # **Azimuth observability enhancement during INS in-flight alignment.** B. Porat and I. Y. Bar-Itzhack (Technion - Israel Institute of Technology, Haifa, Israel). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 80-89. 11 refs. (AIAA 79-1706)

The paper investigates whether an axial acceleration maneuver is superior to a lateral one during the in-flight alignment of an inertial navigation system and whether there exists a simple test or expression which clearly indicates this fact of superiority. It was found that, in general, an axial maneuver is not superior to a lateral one. There are, however, three classes of alignment problems in which axial maneuver is superior. These cases can be modeled by simple models which yield analytic expressions clearly indicating the superiority of the axial maneuver during the in-flight alignment of an INS. B.J.

A79-45361 # **Filtering and threat logic design and evaluation for the beacon collision avoidance system.** J. A. Sorensen and B. Hulland. In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p.90-100. 9 refs. U.S. Department of Transportation Contract No. FAA77NA-4037. (AIAA 79-1707)

The beacon collision avoidance system (BCAS) has been developed as an independent airborne system which provides position measurements of surrounding air traffic. The processed measurements can be used by the pilot for conflict alert and avoidance and for general aiding of the air traffic control process. This paper describes: (1) square-root Kalman filtering developed to process the BCAS measurements, (2) unique airborne threat logic devised to evaluate whether another aircraft poses a threat and how the protected aircraft should maneuver, and (3) the evaluation procedure for assessing BCAS performance by statistical analysis of simulation results. (Author)

A79-45362 * # **Evaluation of the navigation performance of shipboard-VTOL-landing guidance systems.** L. A. McGee, C. H. Paulk, Jr., S. A. Steck (NASA, Ames Research Center, Moffett Field, Calif.), S. F. Schmidt, and A. W. Merz (Analytical Mechanics Associates, Inc., Mountain View, Calif.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 101-113. (AIAA 79-1708)

The objective of this study was to explore the performance of a VTOL aircraft landing approach navigation system that receives data (1) from either a microwave scanning beam (MSB) or a radar-transponder (R-T) landing guidance system, and (2) information data-linked from an aviation facility ship. State-of-the-art low-cost-aided inertial techniques and variable gain filters were used in the assumed navigation system. Compensation for ship motion was accomplished by a landing pad deviation vector concept that is a measure of the landing pad's deviation from its calm sea location. The results show that the landing guidance concepts were successful in meeting all of the current Navy navigation error specifications, provided that vector magnitude of the allowable error, rather than the error in each axis, is a permissible interpretation of acceptable performance. The success of these concepts, however, is strongly dependent on the distance measuring equipment bias. In addition, the 'best possible' closed-loop tracking performance achievable with the assumed point-mass VTOL aircraft guidance concept is demonstrated. (Author)

A79-45363 * # **Fuel-conservative guidance system for powered-lift aircraft.** H. Erzberger and J. D. McLean (NASA, Ames Research Center, Moffett Field, Calif.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 114-128. 9 refs.

A concept for automatic terminal-area guidance, comprising two modes of operation, has been developed and evaluated in flight tests. In the first or predictive mode, fuel-efficient approach trajectories are synthesized in fast time. In the second or tracking mode, the synthesized trajectories are reconstructed and tracked automatically. An energy rate performance model derived from the lift, drag, and propulsion-system characteristics of the aircraft is used in the synthesis algorithm. The method optimizes the trajectory for the initial aircraft position and wind and temperature profiles encountered during each landing approach. The paper describes the design theory and discusses the results of simulations and flight tests using the Augmentor Wing Jet STOL Research Aircraft. (Author)

A79-45373 # **An introduction to co-kill probability estimation in the M on N encounter.** D. S. Hague (Aerophysics Research Corp., Bellevue, Wash.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 243-249. 9 refs. (AIAA 79-1729)

The results obtained from either flight tests or simulated M on N (2 on 2, 2 on 4 through 4 on 4) aerial combat encounters are discussed. The significance of numerical superiority is illustrated along with the necessity to consider kill mechanisms in the formulation of M on N tactics. Two models are evaluated. In the first model very large forces encounter and exchange fire. Results are obtained by the application of stochastic methods alone. In the second model a smaller number of vehicles are engaged. Results are obtained by integrating aircraft trajectories forward in time along with a set of co-kill probability equations which estimate the probability of each aircraft surviving the encounter and the resulting force survival probabilities. V.T.

A79-45376 # **Guidance law design for tactical weapons with strapdown seekers.** T. R. Callen (USAF, Armament Laboratory, Eglin AFB, Fla.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 281-293. (AIAA 79-1732)

A direct measurement of inertial line of sight is not possible with a strapdown seeker, so alternate guidance and filtering techniques must be developed. The objective of the present study is to determine the best combination of guidance law structure, signal processing technology, and achievable seeker and sensor accuracy requirements for the effective use of strapdown seekers with air-to-surface tactical guided weapons. Various filtering techniques and guidance law designs are discussed including direct PN, pursuit guidance, dynamic lead guidance, a combination of PN and pursuit, and a new technique, adaptive PN. This new scheme uses a dither signal to measure and correct for seeker gain errors and overcomes stability problems associated with most of the other approaches. B.J.

A79-45377 # **Optimal missile guidance for low miss and perpendicular impact.** D. V. Stallard (Raytheon Co., Missile Systems Div., Bedford, Mass.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 294-305. 6 refs. (AIAA 79-1734)

A practical terminal guidance law was developed to give low miss distance and perpendicular impact, using optimal control theory with ancillary simple algorithms to find time-to-go, etc. The acceleration commands depend on the projected, zero-control, terminal heading-angle error, and miss distance. When these errors are low, as in the latter part of the intercept, the linearizing assumptions necessary for the closed-form solution hold and the missile trajectory is optimal. All 18 simulation cases had performance well within the requirements and the computational load of the guidance law was relatively low. B.J.

A79-45378 # **A comparison of air-to-air missile guidance laws based on optimal control and differential game theory.** G. M. Anderson (Orincon Corp., La Jolla, Calif.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 306-313. 13 refs. (AIAA 79-1736)

Air-to-air missile guidance laws were derived using optimal control and differential game theory with final miss distance as the optimization criterion. Two simulation scenarios were used to evaluate the guidance laws: one with missile launch near the inner launch boundary and the other near the outer launch boundary. The differential game guidance laws are less sensitive to errors in estimates of current target acceleration than the optimal control laws. The laws based on a perfect missile response performed better for the outer launch boundary scenario, whereas for the inner launch boundary scenario the laws based on a first order missile response achieved smaller miss distances. B.J.

A79-45386 # **Direct force mode flight control for a vectored lift fighter.** A. R. Mitchell (McDonnell Aircraft Co., St. Louis, Mo.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 366-378. (AIAA 79-1744)

The lateral-directional flight control system synthesis for the purely aerodynamic direct force modes and its potential flying qualities with the vectored lift fighter (VLF) are presented. The addition of direct force modes can give air superiority in close-in combat through improved maneuverability and integrated fire-flight control capability over a conventional fighter. These important force modes on the VLF can be designed and mechanized using angle of attack and sideslip feedback in an easily applied system synthesis method. The general methodology used to synthesize flight control of six degrees of freedom is illustrated, and it is shown that good flying qualities are achievable with direct force modes over a wide range of flight conditions. Potential flying qualities with the VLF are exemplified using results from nonlinear six degree of freedom digital simulations. A.T.

A79-45387 # **Minimum expected cost control of linear systems with uncertain parameters - Application to remotely piloted vehicle flight control systems.** A. Vinkler (California Institute of Technology, Pasadena, Calif.), U.-L. Ly (Boeing Co., Seattle, Wash.), R. H. Cannon, Jr. (Stanford University, Stanford, Calif.), and L. J. Wood. In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 379-387. 22 refs. Research supported by Teledyne Ryan Aeronautical. (AIAA 79-1745)

An efficient technique for designing constant gain feedback controllers for linear systems having uncertain or variable parameters is presented and demonstrated for a realistic RPV design. This controller design technique - named Minimum Expected Cost Control - produces closed-loop system behavior which is acceptable for all values of the parameters within specified limits and is optimum in some overall sense. The technique is used to design a constant gain lateral auto-pilot for an RPV that will fly at a wide range of altitudes and airspeeds. Both full and partial state feedback situations are considered. Extension of the method to the design of dynamic feedback compensators is shown to be straightforward. (Author)

A79-45393 # **Deformable mirror surface control - Hardware, algorithms.** D. J. Chiarappa and C. R. Claysmith (General Dynamics Corp., Convair Div., San Diego, Calif.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 435-441. 5 refs. (AIAA 79-1757)

A corrector mirror assembly within an optical train provides corrections to maintain focus on a distant target despite defocus perturbations due to air medium turbulence. Focus correction is by mirror deformation provided by piezoelectric actuators and a companion unique solid-state drive amplifier. Actuation bandpass requirements are 1 kHz. The paper describes the overall actuation control with emphasis on the actuator and drive amplifier design. Hardware examples are shown and discussed. (Author)

A79-45400 # **F-16 flight control system redundancy concepts.** E. E. Ammons (General Dynamics Corp., Fort Worth, Tex.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 484-490. (AIAA 79-1771)

The analog fly-by-wire flight control system (FCS) of the F-16 is discussed. In order to provide undergraded performance following any two like-failures in the stability augmentation electronics, quad-redundant implementation of the pitch stability augmentation was selected, i.e., four branches that are physically and electrically isolated. The branches provide the system back up necessary for safe operation by rejecting the output from a branch that disagrees with two others, and then selecting the middle value of the remaining three. A flight path control, the FCS redundancy implementation, redundancy management, and the FCS gain scheduling are outlined with consideration given to the active selector and hydraulic actuator redundancy. V.T.

A79-45401 # **Development of the Navy H-Dot Automatic Carrier Landing System designed to give improved approach control in air turbulence.** J. M. Urnes, R. K. Hess, R. F. Moomaw (McDonnell Aircraft Co., St. Louis, Mo.), and R. W. Huff (U.S. Navy, Naval Air Test Center, Patuxent River, Md.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 491-501. (AIAA 79-1772)

The Navy Automatic Carrier Landing System (ACLS) provides fully automatic approach and landing capability for high performance carrier-based fighter aircraft. Approach path air turbulence produces significant touchdown error. Using Power Spectral Density definitions of turbulence, a method to determine flight path deviation due to turbulence and effects of changing system control laws to reduce dispersions and improve ACLS performance is presented. This technique, as applied to an F-4J ACLS fleet configuration, results in significant improvement using a vertical rate (H-Dot) reference in the autopilot control law. The F-4J H-Dot avionics mechanization was implemented and flight test results are discussed. (Author)

A79-45402 # **An improved lateral stability augmentation system for air-to-air tracking.** R. R. Huber and R. D. Holdridge (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 502-508. (AIAA 79-1773)

The design of a stability augmentation system for the F-106 aircraft is discussed along with piloted and nonpiloted simulations and flight tests. The system emphasizes improvement in lateral handling qualities for air-to-air (ATA) tracking. Factors effecting ATA tracking are evaluated and the system design and configuration selection is outlined. An estimated side-slip angle rate feedback is used to achieve an improved stability and turn coordination and an increased bandwidth. The design also includes a direct electric signal from a pilot to a control system to allow for a direct command of the side-slip rate. The system eliminates large unintentional side-slip perturbations caused by the pilot's attempts to place a gunsight pipper on a target aircraft. These conclusions are based on pilot comments, gun camera films, and a strip chart data of aircraft parameters. V.T.

A79-45403 * # **Preliminary study of pilot lateral control of two light airplanes near the stall.** M. T. Moul and L. W. Brown (NASA, Langley Research Center, Hampton, Va.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 509-521. 11 refs. (AIAA 79-1775)

For two representative light, single-engine airplanes the single-axis piloting task of controlling bank angle with combined aileron and rudder, and a two-axis task of controlling bank angle with aileron and sideslip with rudder have been studied. For these tasks existing divergence criteria have been applied to determine conditions for closed-loop stability for selected flight conditions near the stall; in addition closed-loop stability characteristics and airplane response to bank angle command were calculated. Results obtained from applying the divergence criterion and from calculations of airplane responses to bank angle command indicate that aileron-alone bank angle control is marginally acceptable at high angle of attack. Of the two rudder control techniques considered, rudder used with the aileron in controlling bank angle increased stability and produced satisfactory responses; the combined bank angle and sideslip control task does not warrant further consideration because of the task difficulty and the small improvement indicated in airplane closed-loop response with this technique. (Author)

A79-45404 # **4-D helical approach of a transport aircraft in an ATC environment.** P. O. Grepper and F. E. Huguenin (Zürich, Eidgenössische Technische Hochschule, Zurich, Switzerland). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 522-528. (AIAA 79-1776)

The results of a simulation study are presented in which a minicomputer was used to compute 4-dimensional (4-d) flight trajectories in an air-traffic control (ATC) environment. The general concepts and the philosophy used in developing the computer controlled system for generating 4-D flight profiles are considered together with application of these concepts for holding, approach, landing, take-off, and go-around problems. The realization of a lift force and lift coefficient on a minicomputer is given as well as the block diagram and the hardware configuration of a lift computer. A test case for a helical approach with a DC-10 is also presented. It is noted that a future study is planned to implement the system on a flight simulator. V.T.

A79-45409 # **Design criteria for optimal flight control systems.** K. S. Govindaraj and E. G. Rynaski (Calspan Advanced Technology Center, Buffalo, N.Y.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 558-566. 5 refs. Contract No. N00014-78-G-0155. (AIAA 79-1782)

Results of the application of linear optimal control to the design of multicontroller feedback system to satisfy aircraft flying qualities are presented. Two sequential design procedures, one computing the Riccati solution from a set of linear equations and the other computing the closed-loop eigenvectors, are presented that determine, at each step, the pole-zero movements of the closed-loop transfer functions as the weighting matrix on the states is varied for a given control weighting matrix. The weighting matrix constructed at each step is added to get a final weighting matrix to move the poles and zeros to more desirable locations. A control system design example, with the X-22A V/STOL aircraft as the model, is presented. (Author)

A79-45410 # **Initial results of an inflight simulation of augmented dynamics in fighter approach and landing.** J. Hodgkinson and K. A. Johnston (McDonnell Aircraft Co., St. Louis, Mo.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 567-572. 10 refs. (AIAA 79-1783)

The USAF/CALSPAN variable stability NT-33 aircraft was used to explore longitudinal and lateral dynamics during landing. The flying qualities of several high order systems and their analytically derived low order equivalents were compared. Pilot ratings were used to determine how closely the low order equivalent system must approximate the high order system to be a valid flying qualities prediction tool. Transport lags in the aircraft response to the pilot's controller were also investigated. (Author)

A79-45412 # **Alleviation of stability and control difficulties of a V/STOL Type B aircraft.** P. W. Berry and J. R. Broussard (Analytic Sciences Corp., Reading, Mass.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 584-593. 23 refs. Contract No. N00014-77-C-0775. (AIAA 79-1785)

High-speed V/STOL aircraft using jet thrust support for VTOL capability can have significant stability and control difficulties in low-speed and hovering flight. In this paper, multivariable time-domain analysis tools are applied to a mathematical model of the AV-8A aircraft to quantify the stability and control variations. The effects of velocity and angle-of-attack, as well as acceleration along and normal to the flight path, are examined. A second section of this paper describes the construction of digitally-implementable command and stability augmentation algorithms for the low-speed and hover regimes. Velocity-, position-, and attitude-command systems for a V/STOL Type B aircraft are illustrated. (Author)

A79-45413 * # **A piloted simulator investigation of helicopter precision decelerating approaches to hover to determine single-pilot IFR /SPIFR/ requirements.** A. V. Phatak (Analytical Mechanics Associates, Inc., Mountain View, Calif.), L. L. Peach, Jr., R. A. Hess, V. L. Ross, G. W. Hall, and R. M. Gerdes (NASA, Ames Research Center, Moffett Field, Calif.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 594-608. 10 refs. (AIAA 79-1886)

The results of single-pilot instrument flight rules (SPIFR) experiments conducted on the NASA-Ames V/STOLAND simulator are presented. Several factors having a significant impact on requirements for helicopter SPIFR decelerating, steep approaches to landing are considered: (1) approach weather conditions, (2) flight path geometry, (3) deceleration guidance law, (4) level of stability and command augmentation, (5) cockpit display sophistication, (6) accuracy of navigation aids, and (7) helipad lighting and visual aids. Particular emphasis is placed on the relative effects of deceleration profile, control augmentation, and flight director parameters on pilot performance, workload, and opinion rating. Problems associated with the development of a pilot acceptance analytical methodology are outlined. V.T.

A79-45414 # **Development of a control wheel steering mode and suitable displays that reduce pilot workload and improve efficiency and safety of operation in the terminal area and in windshear.** A. A. Lambregts and D. G. Cannon (Boeing Commercial Airplane Co., Seattle, Wash.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 609-620. 19 refs. (AIAA 79-1887)

A flight path angle and ground track Control Wheel Steering System development including suitable displays, to reduce pilot workload and improve safety during manual aircraft maneuvering, is discussed. System requirements and design options are reviewed. The rate-command/hold system, using display of both the control variables and their reference commands, is shown to meet information and control handling qualities requirements. The design details to achieve satisfactory control sensitivity, response damping and coordination of pilot and automatic control are described. Both simulator and flight test pilot evaluation results are presented. (Author)

A79-45418 # **Digital flight control reliability - Effects of redundancy level, architecture and redundancy management technique.** J. W. Rice and R. D. McCorkle (Boeing Aerospace Co., Seattle, Wash.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 645-657. (AIAA 79-1893)

The reliabilities of several digital flight control systems (DFCSs) are compared, considering effects of redundancy level, control system architecture, redundancy management philosophy and, where applicable, fault detection and isolation coverage. Realistic reliability data are used for the system components. Each system is described and its success criteria established. It is shown that for longer missions, systems employing interunit selection at the LRU level can be more reliable than systems employing one higher level of redundancy and using midvalue signal voting as the only means of fault detection. (Author)

A79-45421 # **Earth-Referenced Maneuvering Flight Path Display.** J. R. Watler, Jr. and W. B. Logan (Northrop Corp., Aircraft Group, Hawthorne, Calif.). In: Guidance and Control Conference, Boulder, Colo., August 6-8, 1979, Collection of Technical Papers. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 682-691. (AIAA 79-1894)

The investigation of the Maneuvering Flight Path Display (MFPD) field-of-view requirements, the determination of speed index and flight path display formats, and the mechanization of an earth-referenced transition path (for use when the MFPD moves outside the display field-of-view) are presented. The basic Earth-Referenced MFPD computer program was modified to incorporate the extended functional capability resulting from this work, a modified computer program was validated by 'flying' it in real time from a cockpit simulator, and an improved version of the ER/MFPD was obtained from the study. It is noted that air-to-air engagements, air-to-surface moving target strikes, and carrier approaches and landings require a moving reference version of the flight path. V.T.

A79-45600 **Liquid hydrogen fueled commercial aircraft.** G. D. Brewer (Lockheed-California Co., Burbank, Calif.). In: Hydrogen for energy distribution; Proceedings of the Symposium, Chicago, Ill., July 24-28, 1978. Chicago, Institute of Gas Technology, 1979, p. 541-550.

This statement reviews the probable future fuel problem facing the commercial air transport industry and suggests an innovative course of action. The plan involves creation of an experimental airline equipped with four liquid hydrogen-fueled, wide-body aircraft flying commercial cargo on a regularly scheduled basis between the United States, Western Europe, and the Middle East. Development of facilities incorporating advanced technologies for production and liquefaction of hydrogen at each of four major air terminals is an integral part of the plan. (Author)

A79-46055 # **Enthalpies of combustion of ramjet fuels.** N. K. Smith and W. D. Good (U.S. Department of Energy, Bartlesville Energy Technology Center, Bartlesville, Okla.). *AIAA Journal,* vol. 17, Aug. 1979, p. 905-907. 16 refs. Grant No. AF-AFOSR-ISSA-78-0009.

The paper gives details of experimental measurements of the enthalpies of combustion of four hydrocarbon liquids being evaluated as ramjet fuels: exo-THDC, RJ-4, RJ-4-I, and JP-9. The four liquids have high enthalpies of combustion per unit volume. Attention is given to calibration, calorimetric results, and derived results. B.J.

A79-46060 # **Axisymmetric calculations of transonic wind tunnel interference in slotted test sections.** K. R. Karlsson and Y. C.-J. Sedin (Saab-Scania AB, Aerospace Div., Linkoping, Sweden). *AIAA Journal,* vol. 17, Aug. 1979, p. 917-919.

A study has been performed to investigate Berndt's inviscid theory (1977) of wall interference in slotted test sections. Only axisymmetric flows have been calculated, though there is no limit to the theory. The wall interference on the model has been defined through a single number, called the figure of tunnel interference (FTI). The FTI is based on an average value of the difference in model surface pressure between the tunnel case and the simulated freestream case. Two different tunnel blocking ratios are demonstrated for a parabolic arc body mounted on a sting at two different Mach numbers, the higher of which gives a fully choked test section. B.J.

A79-46225 **Monitoring stratospheric winds with Concorde-generated infrasound.** W. L. Donn and D. Rind (Lamont-Doherty Geological Observatory, Palisades, N.Y.). *Journal of Applied Meteorology,* vol. 18, July 1979, p. 945-952. 6 refs. FAA-NSF-Army-supported research.

The relatively low frequency of the sonic boom generated by the Concorde SST permits propagation in the form of infrasound to long range with small attenuation. Signal characteristics at long range are a function of atmospheric propagation parameters. When the relationship of propagation to signal is understood, the propagation conditions can be determined by inversion with good accuracy. It is shown how signal recorded at Palisades, New York, from the Dulles-bound SST reveals direction and speed of stratospheric wind variations diurnally and seasonally and also gives details of at least local circulation change at times of stratospheric warmings. (Author)

A79-46238 * # **Demonstration of aircraft wing/store flutter suppression systems.** C. Hwang, B. A. Winther, G. R. Mills (Northrop Corp., Hawthorne, Calif.), T. E. Noll (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio), and M. G. Farmer (NASA, Langley Research Center, Hampton, Va.). *Journal of Aircraft,* vol. 16, Aug. 1979, p. 557-563. 13 refs. Contract No. F33615-76-C-3039.

A wind tunnel test program was conducted to demonstrate the active wing/store flutter suppression systems on a lightweight fighter aircraft. The program, completed in mid-1978, included the design, analysis, fabrication, and testing of a scale model. The tests were conducted at the NASA Langley 16-ft Transonic Dynamics Tunnel. Three store configurations were selected for testing. Two of these configurations were deliberately designed to exhibit low flutter speeds with rapid reductions in damping at the incipient flutter condition. After initial tunnel entries, which showed the need for certain improvements in the model and the control system design, substantial increases in the flutter speeds were achieved using both leading- and trailing-edge control surfaces, separately. For the most critical configuration, a demonstrated improvement of 18% and a projected improvement of 29% in the dynamic pressure were achieved. (Author)

A79-46240 **Aerial isolation - a study of the interaction between co-sited aerials.** D. A. Bull and B. W. Smithers (Electrical Research Association, Ltd., Leatherhead, Surrey, England). *Radio and Electronic Engineer,* vol. 49, June 1979, p. 289-296. 8 refs. Research supported by the Ministry of Defence (Procurement Executive).

The increased complexity of modern aircraft has resulted in a proliferation of antennas sited in close proximity to one another, a trend more marked in military types, which makes it even more necessary to ensure compatibility of working in a crowded RF spectrum. The paper presents the investigations that have been made to determine the degree of isolation between transmitting and receiving antennas in aircraft within the frequency range 30 to 1250 MHz. From measurements using cylinders, ground planes, helicopters and fixed-wing aircraft, empirical formulas for the calculation of antenna-to-antenna isolation have been derived. Investigations have also been carried out to determine the amplitude of the harmonics generated by airborne transmitters. The results obtained from both these aspects of the work are discussed. (Author)

A79-46241 **Reflection elimination in secondary surveillance radar.** B. A. Wyndham (Royal Signals and Radar Establishment, Great Malvern, Worcs., England). *Radio and Electronic Engineer,* vol. 49, June 1979, p. 311-322. 7 refs.

Two major approaches for reducing reflections in secondary surveillance radars (SSR) are presented. Both uplink interrogation and downlink reply methods can be employed for reducing the cross section of the reflector, improving antennas, and siting. In addition, the uplink methods can be used for modifying interrogation signal formats and transponder circuits, while the downlink methods are useful for recognizing particular characteristics of reflected signals. It is noted that apart from sensible site evaluation and appropriate antenna design, only two effectual ways are found for existing sites: using either hardware or software reflection detectors, or both, in the downlink receiver system. V.T.

A79-46466 **The global positioning system /NAVSTAR/.** B. W. Parkinson (Colorado State University, Fort Collins, Colo.). *Bulletin Géodésique,* vol. 53, no. 2, 1979, p. 89-108.

The NAVSTAR navigational satellite system concept is described. Three major segments are covered: (1) the space segment, consisting of 24 satellites, 8 each in three approximately circular orbits at 10,900 nautical miles, with orbital periods of 12 hours, (2) the control segment which monitors the functions of the satellite and precisely calibrates their future locations, and (3) the users which include land, sea, air and space navigation users. Attention is given to the basic system technique, expected system accuracy, applications, and test results to date. M.E.P.

A79-46686 * # **Numerical investigation of the perpendicular injector flow field in a hydrogen fueled scramjet.** J. P. Drummond (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, Va.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1482.* 13 p. 17 refs.

A computer program has been developed which numerically solves the full (elliptic) two-dimensional Navier-Stokes and specie equations near a slotted perpendicular hydrogen fuel injector in a scramjet engine. The program currently predicts the turbulent mixing of injected hydrogen fuel and air without reaction, and allows the study of separated regions of flow immediately preceding and following the injector as well as the complex shock-expansion structure produced by the injector in this region of the engine. Results are presented that describe the size of the separated regions near the injector as well as locations where ignition is likely to occur. (Author)

A79-46691 * # **Application of stability theory to laminar flow control.** J. N. Hefner and D. M. Bushnell (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, Va.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1493.* 20 p. 104 refs.

The paper summarizes the state-of-the-art for application of stability theory to laminar flow control using suction, wall temperature and/or favorable pressure gradient ('natural laminar flow'). Discussions include current LFC problem areas requiring stability analyses, methods of relating stability theory to transition with results from data and theory comparisons available thus far, and a summary of low disturbance data available for theory calibration on swept wings. Critical issues highlighted are problems peculiar to suction LFC on high performance transonic wings and application of the e-to-the-n-power method to both low and high speed flight data. (Author)

A79-46692 # **The stability of the boundary layer on a swept wing with wall cooling.** S. G. Lekoudis. *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1495.* 11 p. 26 refs. Research supported by the Lockheed-Georgia Independent Research and Development Program.

Linear stability theory is used to examine the propagation of laminar instabilities in the leading edge region of a transonic swept wing with wall cooling. Before this could be done, the effects of computing real group velocity ratios for monochromatic waves needed investigation. When crossflow disturbances were computed using spatial theory and for a limited range of angles of wavegrowth direction, the growth rate in the direction formed by the real ratio of the group velocities and the direction itself were insensitive to the orientation of the wave growth. When temporal theory was used, this condition resulted in a single wave of maximum amplification. It is found that wall cooling has a stabilizing effect on crossflow disturbances, but the stabilization is mild compared to the stabilizing effect that wall cooling has on Tollmien-Schlichting waves. (Author)

A79-46693 # **Investigation of three-dimensional shock/boundary layer interactions at swept compression corners.** G. S. Settles and J. J. Perkins (Princeton University, Princeton, N.J.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1498.* 14 p. 18 refs. Contract No. F44620-75-C-0080.

The paper discusses the first phase of an experimental investigation of a three-dimensional shock wave/turbulent boundary layer interaction. Compression corners of 16-deg and 24-deg angles which cause near-incipient and well-separated two-dimensional flows at Mach 3 are systematically swept through angles up to 50 deg, while maintaining a constant streamwise corner angle. The resulting three-dimensional flows are studied by means of detailed surface measurements and a few exploratory flowfield surveys. Tests at four Re numbers reveal that a Re-number influence on the interaction length remains in effect across the available range of sweep. B.J.

A79-46694 * # **Transonic flow past a symmetrical airfoil at high angle of attack.** D. A. Johnson, F. K. Owen (NASA, Ames Research Center, Moffett Field, Calif.), and W. D. Bachalo (NASA, Ames Research Center, Moffett Field; Spectron Development Laboratories, Inc., Costa Mesa, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1500.* 15 p. 21 refs.

The results of an experimental investigation of shock-induced stall and leading-edge stall on a 64A010 airfoil section are presented. Advanced nonintrusive techniques - laser velocimetry, holographic interferometry, and buried-wire anemometry - were used in characterizing the inviscid and viscous flow regions. The measurements include Mach contours of the inviscid flow regions, and mean velocity, flow direction and Reynolds shear stress profiles in the separated regions. The experimental observations of this study are relevant to efforts to improve surface pressure prediction methods for airfoils at or near stall. (Author)

A79-46695 # **Supercritical airfoil boundary-layer measurements.** F. W. Spaid (McDonnell Douglas Research Laboratories, St. Louis, Mo.) and L. S. Stivers, Jr. *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1501.* 14 p. 23 refs.

A series of experiments was conducted on flowfields about two models which had sections that were slight modifications of the original Whitcomb supercritical airfoil section. Boundary-layer profiles were obtained on both upper and lower surfaces for combinations of lift coefficient and freestream Mach number including both subcritical cases and flows with upper-surface shocks. The data are intended to provide test cases for comparison with predictions of numerical computations, and to contribute to a more detailed understanding of the mechanisms associated with transonic drag rise. Comparisons are made between measured boundary-layer properties and results from boundary-layer computations which employed measured static-pressure distributions. (Author)

A79-46697 * # **Trailing-edge flows at high Reynolds number.** P. R. Viswanath, J. W. Cleary, H. L. Seegmiller, and C. C. Horstman (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1503.* 17 p. 22 refs.

An investigation of trailing-edge flows at high Reynolds number and subsonic Mach numbers is presented. Symmetric and asymmetric trailing-edge flows are studied, each flow having pressure gradient regions upstream of the trailing edge similar to an airfoil. Measurements include model surface pressures, mean velocity, turbulent shear stress, and turbulent kinetic energy profiles in the trailing-edge and near-wake regions. Comparisons of the symmetric data with numerical solutions of boundary layer as well as Navier-Stokes equations employing two different turbulence models show increasing effects on viscous interactions as the Mach number increases. Both turbulence models yielded solutions of the mean flow of comparable quality. The experimental results of the asymmetric case are discussed. (Author)

A79-46701 * # **A careful numerical study of flowfields about external conical corners. I - Symmetric configurations.** M. D. Salas (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, Va.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1511.* 10 p. 15 refs.

A numerical study of the flowfield about symmetrical external axial corners formed by the juncture of swept compressive wedges is presented. The geometrical configuration under investigation allows a unified treatment of external corners typical of delta wings and of rectangular inlets. Comparisons are made with other numerical results. For the delta wing configuration, the occurrence of an anomalous shock behavior predicted by Gonor is discussed. A parametric study shows the singular behavior of the pressure at the corner as a function of the external corner angle, and a second parametric study shows the effect of finite corner radius on the location of the crossflow stagnation point. Previous theoretical predictions of certain flow features typical of corner flows agree well with present numerical results. (Author)

A79-46702 * # **Recent progress in finite-volume calculations for wing-fuselage combinations.** D. A. Caughey (Cornell University, Ithaca, N.Y.) and A. Jameson (New York University, New York, N.Y.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1513.* 13 p. 12 refs. Contracts No. N00014-78-C-0079; No. NAS-9913.

Progress in the application of finite-volume methods to the calculation of transonic potential flows past general wing-body combinations is reviewed. Two different methods of generating boundary-conforming grids are investigated, and the results compared to provide an estimate of solution sensitivity to grid geometry. Both conservative and quasi-conservative difference schemes are used in one of the coordinate systems. Results show that the error introduced by the quasi-conservative formulation seems to be small, although a one-dimensional analysis suggests that schemes of this type do not necessarily produce mass-conserving shocks. Comparison of calculated results with experimental data for realistic fuselage geometries clearly shows the importance of modelling the effect of fuselage geometry upon the wing pressure distribution. (Author)

A79-46703 # **The effect of blade-to-blade flow variations on the mean flow-field of a transonic compressor.** A. K. Sehra (General Electric Co., Lynn, Mass.) and J. L. Kerrebrock (MIT, Cambridge, Mass.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1515.* 12 p. 16 refs. Contract No. F-33615-76-C-2118.

The axisymmetric mean flow field of a highly loaded transonic compressor rotor can be accurately predicted by a theory which includes the effects of blade-to-blade flows on the axisymmetric mean by peripheral averaging. In highly loaded rotors the most important effects of the blade-to-blade flow on the axisymmetric mean arise from radial flows due to boundary layers and wakes. Of the three effects modeled, namely apparent stresses, mean rothalpy variation, and apparent entropy variation along streamsurfaces, the last two dominate the departure of the real flow from the conventionally treated axisymmetric flow. B.J.

A79-46704 # **Subsonic flow past an oscillating cascade with finite mean flow deflection.** J. M. Verdon and J. R. Caspar (United Technologies Research Center, East Hartford, Conn.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1516.* 12 p. 21 refs. Research sponsored by the United Technologies Corp.

A theoretical model for predicting the aerodynamic response due to a finite-deflection cascade oscillating in a subsonic stream is described. Based on the assumption of small amplitude harmonic blade motions, the unsteady flow is treated as a small fluctuation about the non-uniform mean flow. The mean or steady flow is determined as a solution of the full potential equation while the unsteady flow is governed by a linear equation with variable coefficients which depend on the steady flow field. Numerical solutions based on this general aerodynamic model have been obtained for simple cascade configurations. Selected results for sharp-edge blade profiles are described. Those for flat plate cascades are shown to be in good agreement with previous analytical predictions for both subresonant and superresonant blade motions. Predictions for double circular arc and thin circular arc profiles reveals that blade thickness has a significant effect on the unsteady response while the effect of flow turning due to blade camber is only minimal. (Author)

A79-46705 # **An iterative lifting surface method for thick bladed hovering helicopter rotors.** K. R. Shenoy and R. B. Gray (Georgia Institute of Technology, Atlanta, Ga.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1517.* 8 p. 17 refs.

A prescribed-wake, inviscid, lifting-surface method using surface vorticity distributions is developed to predict the pressure distribution on thick-bladed helicopter rotors in hover. Starting with an approximate surface vortex sheet strength distribution, the final strength distribution is computed iteratively by applying the Biot-Savart law. The convergence rate is rapid, and reasonably good results can be obtained within three iterations. The results show good agreement with the experimental results except for very near the tip of the blade. At spanwise stations inboard of the maximum blade bound circulation, the results indicate adequacy of the lifting-line representation for the blade. (Author)

A79-46709 * # **Peak Strouhal frequency of subsonic jet noise as a function of Reynolds number.** K. Yamamoto (New York, State University, Buffalo, N.Y.) and R. E. A. Arndt (Minnesota, University, Minneapolis, Minn.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1525.* 6 p. 12 refs. USAF-supported research; Grant No. NGR-39-009-270.

An experimental study of the narrowband spectra of radiated sound from subsonic jets is discussed. It is found that the acoustic field is Reynolds-number-dependent below a Reynolds number of about 200,000. This has important implications for the study of coherent structures as radiators of sound. B.J.

A79-46710 * # **Opportunities for supersonic performance gains through non-linear aerodynamics.** W. H. Mason and G. DaForno (Grumman Aerospace Corp., Aerodynamics Section, Bethpage, N.Y.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1527.* 21 p. 33 refs. Research sponsored by the Grumman Advanced Development Program; Contract No. NAS1-15351.

This paper contains a number of examples wherein basic aerodynamic shapes are shown to achieve improved performance when non-linear effects are taken into account. Analytical, numerical, and experimental results have all been used to demonstrate this conclusion. Improvements in both zero lift drag and drag due to lift have been identified. The results show that the exploitation of these non-linear aerodynamic effects may be a key ingredient of future supersonic aircraft. (Author)

A79-46711 # **Technique for developing design tools from the analysis methods of computational aerodynamics.** W. H. Davis, Jr. (Grumman Aerospace Corp., Aerodynamics Section, Bethpage, N.Y.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1529.* 10 p. 17 refs. Research supported by the Grumman Aerospace Corp.

An initial attempt at a technique to generate, simply and rapidly, mixed direct-inverse codes from their direct counterparts is presented. A surface alteration procedure, keyed to flow type for the mixed case, is 'wrapped around' an existing direct code. The difference between calculated and target pressures determines surface modifications. The direct code is used as a 'black box'. The technique features retention of the strength of the direct analysis and easy interchangeability of the analysis code. The technique is demonstrated in two cases, a nonlinear supersonic wing code and a transonic airfoil code. (Author)

A79-46712 # **Water tunnel flow visualization - Insight into complex three-dimensional flow fields.** G. E. Erickson (Northrop Corp., Hawthorne, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1530.* 17 p. 18 refs.

Water tunnel facilities and flow visualization techniques have been developed at Northrop to provide high-quality visualization of vortex interactions at high angles of attack. Results have provided considerable insight into highly-complex three-dimensional flow fields generated by contemporary fighter aircraft. Studies have been made of the leading-edge vortex systems generated by wing leading-edge extensions (LEX) typical of current subsonic-transonic fighter aircraft, high angle-of-attack aerodynamic asymmetries associated with the vortex system developed on long slender forebodies, and forebody and wing/LEX vortex interactions characteristic of highly-maneuverable aircraft with hybrid wing planforms and slender forebodies. Qualitative results are in excellent agreement with existing subsonic wind tunnel data. The water-to-air analogy has been verified, that is, aircraft forebody and wing/LEX vortex systems, vortex system interactions, and the downstream influence on flow characteristics exhibited in air at high Reynolds numbers can be simulated at low Reynolds numbers in the water tunnel. (Author)

A79-46713 # **Steady and unsteady vortex-induced asymmetric loads - Review and further analysis.** L. E. Ericsson (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1531.* 22 p. 82 refs. Contract No. N60921-77-C-0234.

The unsteady aerodynamic characteristics of a cylinder normal to the flow have been studied in order to obtain a better understanding of the steady and unsteady vortex-induced asymmetric loads on slender axi-symmetric bodies at high angles of attack. It is found that the coupling between flow separation and body surface motion, which is significant even for purely laminar or turbulent flow, becomes very much stronger when boundary layer transition occurs near the flow separation. Thus, at transcritical Reynolds numbers the asymmetric loads become almost one order of magnitude larger and additionally are reversed in sign relative to the loads at subcritical and supercritical flow conditions. It is shown how these effects can be explained using a moving wall/wall jet analogy. (Author)

A79-46714 * # **Evaluation of flow quality in two NASA transonic wind tunnels.** F. K. Owen, P. C. Stainback, and W. D. Harvey (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma*

Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1532. 11 p. 16 refs. Contracts No. NAS1-14833; No. NAS1-15223.

Tests have been conducted in the Langley Research Center 8-foot Transonic Pressure Tunnel and the Ames Research Center 12-foot pressure wind tunnel in order to measure characteristic disturbance levels and energy spectra in their respective settling chambers, test sections, and diffusers and to determine the sources of these disturbances. Results are presented and discussed along with some specific recommendations. B.J.

A79-46715 * # **Effect of viscosity on wind-tunnel wall interference for airfoils at high lift.** L. E. Olson (NASA, Ames Research Center, Moffett Field, Calif.) and S. Stridsberg (Flygtekniska Forsoksanstalten, Bromma, Sweden). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1534.* 7 p. 21 refs.

The effect of the walls of a wind tunnel on the subsonic, two-dimensional flow past airfoils at high angles of attack is studied theoretically and experimentally. The computerized analysis, which is based on iteratively coupled potential-flow, boundary-layer, and separated-flow analyses, includes determining the effect of viscosity and flow separation on the airfoil/wall interaction. Predictions of the effects of wind-tunnel wall on the lift of airfoils are compared with wall corrections based on inviscid image analyses, and with experimental data. These comparisons are made for airfoils that are large relative to the size of the test section of the wind tunnel. It is shown that the inviscid image modeling of the wind-tunnel interaction becomes inaccurate at lift coefficients near maximum lift or when the airfoil/wall interaction is particularly strong. It is also shown that the present method of analysis (which includes boundary-layer and flow-separation effects) will provide accurate wind-tunnel wall corrections for lift coefficients up to maximum lift. (Author)

A79-46719 * # **The prediction of the turbulent flow field about an isolated airfoil.** S. J. Shamroth and H. J. Gibeling (Scientific Research Associates, Inc., Glastonbury, Conn.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1543.* 15 p. 55 refs. Contract No. NAS1-15214.

A compressible time-dependent solution of the Navier-Stokes equations including a transition-turbulence model is obtained for the isolated airfoil flow field problem. The equations are solved by a consistently split linearized block implicit scheme due to Briley and McDonald. A nonorthogonal body fitted coordinate system is used which has maximum resolution near the airfoil surface and in the region of the airfoil leading edge. The transition-turbulence model is based upon the turbulence kinetic energy equation and predicts regions of laminar, transitional and turbulent flow. Mean flow field and turbulence field results are presented for an NACA 0012 airfoil at zero and nonzero incidence angles at Reynolds number up to one million and low subsonic Mach numbers. (Author)

A79-46726 # **Results of an improved version of LTRAN2 for computing unsteady airloads on airfoils oscillating in transonic flow.** R. Houwink and J. van der Vooren (Nationaal Lucht- en Ruimtevaartlaboratorium, Amsterdam, Netherlands). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1553.* 8 p. 9 refs. Research supported by the Netherlands Agency for Aerospace Programs.

Using an improved version of the NASA Ames code LTRAN2, unsteady airloads were computed for a flat plate and a lifting transonic NACA 64 A006 airfoil, for harmonic pitch and control surface motions at reduced frequencies based on semi-chord 0 not greater than k not greater than 0.8. The main improvement of the code was obtained by adding appropriate unsteady terms to the boundary conditions as well as to the expression for the pressure coefficient. The results demonstrate the considerably extended range of applicability of LTRAN2 in terms of reduced frequency, typically from 0.15 to 0.4. The specific transonic character of the unsteady airloads on the NACA 64 A006 airfoil is shown to be very strong at low values of k. With increasing k the effect of the transonic flow on the unsteady airloads diminishes rapidly, so that for k greater than 0.4 lifting surface theory becomes an increasingly useful alternative. (Author)

A79-46730 # **Adverse pressure gradients effects on supersonic boundary layer turbulence.** A. J. Laderman (Ford Aerospace and Communications Corp., Newport Beach, Calif.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1563.* 12 p. 23 refs. Contract No. F33615-77-c-3016.

Measurements were made of mean flow profiles at several streamwise locations in a supersonic turbulent boundary layer growing under a continuous adverse pressure gradient, tests were performed at Mach 3 using two curved ramps designed to produce constant pressure gradient flows. Analysis of the profile data indicates that with an appropriate compressibility transformation, the data correlates with the well-defined Coles 'wall-wake' incompressible velocity profile. In addition, correlation of the wake parameter and the Clauser shape factor with the local pressure gradient is in agreement with the low speed data. B.J.

STAR ENTRIES

N79-28119# Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).
HIGH REYNOLDS NUMBER SUBSONIC AERODYNAMICS
Apr. 1969 584 p refs Lecture held at Rhode-Saint-Genese, Belgium, 21-25 Apr. 1969
(VKI-Lecture-Series-16) Avail: NTIS HC A25/MF A01

Problems associated with the design of large subsonic aircraft are addressed with emphasis on scale effect, aerodynamic loads, and the reduction of drag, noise, and vibration. The use of interactive systems and computer graphics in aircraft design is also examined.

N79-28120# Lockheed-Georgia Co., Marietta.
ADVANTAGES AND PROBLEMS OF LARGE SUBSONIC AIRCRAFT
B. H. Little, Jr. *In* Von Karman Inst. of Fluid Dyn. High Reynolds Number Subsonic Aerodyn. Apr. 1969 30 p refs

Avail: NTIS HC A25/MF A01

The current and projected demand for large subsonic aircraft, both commercial and military, is discussed with emphasis on the advantages provided by these aircraft in economy, drag reduction, passenger comfort, and lessened air traffic congestion. Aerodynamically, the most important problems to be solved concern: wing design for high subsonic speeds; wing design for good low speed performance; stability and aeroelastic effects; total configuration design and optimization; propulsion system integration requirements; and fluid flow scaling effects due to large vehicle size. The need for better mathematical tools to provide theoretical solutions to high speed wind design to supercritical flow problems is discussed. A.R.H.

N79-28121# Lockheed-Georgia Co., Marietta.
AEROMECHANICS
B. H. Little, Jr. *In* Von Karman Inst. for Fluid Dyn. High Reynolds Number Subsonic Aerodyn. Apr. 1969 80 p refs

Avail: NTIS HC A25/MF A01

Relatively speaking, low-frequency interactions between an aircraft and its flight environment are examined. The fundamental concepts of unsteady aerodynamics and the present status of unsteady aerodynamic theory are discussed. Significant problems related to large subsonic aircraft explored concern self-induced buffet, whirl flutter, wing flutter, transonic buffet, buzz phenomena, and aeroelastic optimization. A.R.H.

N79-28122# Lockheed-Georgia Co., Marietta.
SCALING EFFECTS ON SHOCK-INDUCED SEPARATION

B. H. Little, Jr. *In* Von Karman Inst. for Fluid Dyn. High Reynolds Number Subsonic Aerodyn. Apr. 1969 33 p refs

Avail: NTIS HC A25/MF A01

Data from wind tunnel tests and subsequent flight tests of the C-141 aircraft indicate strong possibility that scaling effects are associated with separation of the boundary layer at and downstream of the shock waves. Features of the general flow model used to establish scaling criteria are discussed. Experiments reported include investigations of shock-induced separation on circular arc airfoils in a small transonic nozzle; a study of the initial boundary layer effects on transonic shock-induced separation in an axisymmetric nozzle; tests of a simulated C-141 in the 4' x 6' nozzle, and tests of a swept wing panel model in the NASA-Ames 11 ft transonic tunnel. The sensitivty of flows with separation or incipient separation at the trailing edge and the conditions necessary for wind tunnel simulation of transonic flight are examined. A.R.H.

N79-28123# Lockheed-Georgia Co., Marietta. C-5A Aerodynamics Dept.
SCALING EFFECTS ON DRAG PREDICTION
J. H. Paterson *In* Von Karman Inst. for FLuid Dyn. High Reynolds Number Subsonic Aerodyn. Apr. 1969 36 p

Avail: NTIS HC A25/MF A01

The intended purpose of wind tunnel tests and the component drags which compose the total cruise drag are examined in this discussion of the effects of Reynolds number on drag. The prediction of full scale drag requires highly refined accurate wind tunnel procedures to insure that the transition from laminar to turbulent flow is identified or controlled. Experience with fixing the transition on C-5A models shows that some increment in drag-rise Mach number will be obtained full scale. The transition strip was located at 7% chord aft of the leading edge of the wing root, increasing to 19% at the tip. Calculations show that the nondimensional boundary layer thickness at 50% chord on the model is about 50% greater than predicted full scale values at 20% semispan and 32% at 95% semispan. A.R.H.

N79-28124# Southampton Univ. (England).
NOISE AND VIBRATION PROBLEMS: OUTLINE NOTES

P. E. Doak *In* Von Karman Inst. for Fluid Dyn. High Reynolds Number Subsonic Aerodyn. Apr. 1969 9 p

Avail: NTIS HC A25/MF A01

The fundamental concepts and techniques of aerodynamic noise and vibration are outlined. R.E.S.

N79-28125# Lockheed-Georgia Co., Marietta.
WING DESIGN, BODY DESIGN, HIGH LIFT SYSTEMS AND FLYING QUALITIES WITH INTRODUCTION
D. Ryle *In* Von Karman Inst. for Fluid Dyn. High Reynolds Number Subsonic Aerodyn. Apr. 1969 286 p

Avail: NTIS HC A25/MF A01

Aerodynamic design process techniques are discussed from an aircraft company's point of view. The following areas of design are described: (1) parametric design techniques; (2)wing design; (3) body design; (4) high lift systems; and (5) flying qualities. R.E.S.

N79-28126# Lockheed-Georgia Co., Marietta.
ADVANCED COMPUTER TECHNOLOGY IN AERODYNAMICS. LECTURE 1: COMPUTER-AIDED AIRCRAFT DESIGN
B. H. Little, Jr. *In* Von Karman Inst. for Fluid Dyn. High Reynolds Number Subsonic Aerodyn. Apr. 1969 37 p refs

Avail: NTIS HC A25/MF A01

Computer graphic applications to aerodynamics are presented. Computer programs on aircraft design, pressure reduction, numerical control, and structural analysis are described. R.E.S.

N79-28129# Information Spectrum, Inc., Warminster, Pa.
MAINTENANCE IMPROVEMENT: AN ANALYSIS APPROACH INCLUDING INFERENTIAL TECHNIQUES. VOLUME 1: OVERVIEW Final Report, 27 Dec. 1977 - 15 Mar. 1979
Milton Clyman and Philip S. Grenetz 15 Mar. 1979 42 p refs 3 Vol.
(Contract MDA903-78-C-0176)
(AD-A068380; ISI-W-7958-02A-Vol-1) Avail: NTIS HC A03/MF A01 CSCL 01/3

This final report, contained in four volumes, presents the results of research into assessing the economic (cost and down-time) impact of Potentially Avoidable Maintenance actions for selected Naval aircraft subsystems. Maintenance actions requiring no repair and those resulting in induced defects and failure-to-correct were identified. Specific high-driver two-digit

Work Unit Codes were analyzed for the F-14A Fire Control, S-3A Bombing Navigation, S-3A Landing Gear, and A-7E Bombing Navigation. GRA

N79-28130# Information Spectrum, Inc., Warminster, Pa.
MAINTENANCE IMPROVEMENT: AN ANALYSIS APPROACH INCLUDING INFERENTIAL TECHNIQUES. VOLUME 2: TECHNICAL REPORT Final Report, 27 Dec. 1977 - 15 Mar. 1979
Milton Clyman, Philip S. Grenetz, and Richard S. Schultz 15 Mar. 1979 190 p refs 3 Vol.
(Contract MDA903-78-C-0176)
(AD-A068381; ISI-W-7958-02B-Vol-2) Avail: NTIS HC A09/MF A01 CSCL 01/3

Research methodology, results, and recommendations are presented. The interim feasibility report is appended. A.R.H.

N79-28131# Information Spectrum, Inc., Warminster, Pa.
MAINTENANCE IMPROVEMENT. AN ANALYSIS APPROACH INCLUDING INFERENTIAL TECHNIQUES. VOLUME 4: SOFTWARE MANUAL Final Report, 27 Dec. 1977 - 15 Mar. 1979
Milton Clyman, Vito A. Gentile, and Philip S. Grenetz 15 Mar. 1979 164 p 3 Vol.
(Contract MDA903-78-C-0176)
(AD-A068383; ISI-W-7958-02D-Vol-4) Avail: NTIS HC A08/MF A01 CSCL 01/3

Volume IV includes the logic used to develop software for generating the tables in Volume III, user instructions, and a complete listing of programs that were executed to arrive at the tables. GRA

N79-28134*# Kentron International, Inc., Hampton, Va. Technical Center.
SENSITIVITY STUDY FOR A REMOTELY PILOTED MICROWAVE-POWERED SAILPLANE USED AS A HIGH-ALTITUDE OBSERVATION
R. Victor Turriziani Jun. 1979 15 p refs
(Contract NAS1-13500)
(NASA-CR-159089) Avail: NTIS HC A02/MF A01 CSCL 01A

The sensitivity of several performance characteristics of a proposed design for a microwave-powered, remotely piloted, high-altitude sailplane to changes in independently varied design parameters was investigated. Results were expressed as variations from baseline values of range, final climb altitude and onboard storage of radiated energy. Calculated range decreased with increases in either gross weight or parasite drag coefficient; it also decreased with decreases in lift coefficient, propeller efficiency, or microwave beam density. The sensitivity trends for range and final climb altitude were very similar. The sensitivity trends for stored energy were reversed from those for range, except for decreasing microwave beam density. Some study results for single parameter variations were combined to estimate the effect of the simultaneous variation of several parameters: for two parameters, this appeared to give reasonably accurate results. A.R.H.

N79-28136*# New York Univ., N. Y. Courant Mathematics and Computing Lab.
AN ARTIFICIAL VISCOSITY METHOD FOR THE DESIGN OF SUPERCRITICAL AIRFOILS
Geoffrey B. McFadden Jul. 1979 168 p refs
(Grants NGR-33-016-201; NsG-1579; Contract EY-76-C-02-3077)
(NASA-CR-158840; COO-3077-158) Avail: NTIS HC A08/MF A01 CSCL 01A

A numerical technique is presented for the design of two-dimensional supercritical wing sections with low wave drag. The method is a design mode of the analysis code H which gives excellent agreement with experimental results and is widely used in the aircraft industry. Topics covered include the partial differential equations of transonic flow, the computational procedure and results; the design procedure; a convergence theorem; and description of the code. A.R.H.

N79-28138*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
THE EFFECT OF CANARD RELATIVE SIZE AND VERTICAL LOCATION ON THE SUBSONIC LONGITUDINAL AND LATERAL-DIRECTIONAL STATIC AERODYNAMIC CHARACTERISTICS FOR A MODEL WITH A SWEPT FORWARD WING
Jarrett K. Huffman and Charles H. Fox, Jr. Jul. 1979 106 p refs
(NASA-TM-78739) Avail: NTIS HC A06/MF A01 CSCL 01A

A general research fighter model was tested in the Langley 7- by 10-foot high speed tunnel at a Mach number of 0.3. The model was tested with a 32 deg swept forward wing mounted in mid-, low-, and high-wing positions. For the mid-wing configuration, the model was tested with a 51.7 deg swept back canard mounted in mid-, low-, and high-canard positions. For the mid-wing mid-canard and the mid-wing high-canard configurations, canards of similar planform having two different areas were tested. The angle-of-attack range was from approximately -4 deg to 48 deg at sideslip angles of 0 deg, -5 deg, and 5 deg. Author

N79-28142*# Rockwell International Corp., Columbus, Ohio.
LOW SPEED WIND TUNNEL TEST OF GROUND PROXIMITY AND DECK EDGE EFFECTS ON A LIFT CRUISE FAN V/STOL CONFIGURATION, VOLUME 2 Contractor Report, Mar. 1978 - Feb. 1979
V. R. Stewart May 1979 484 p
(Contract NAS2-9882)
(NASA-CR-152248; NR79H-12-Vol-2) Avail: NTIS HC A21/MF A01 CSCL 01A

The following test results are appended: (1) wind tunnel data, (2) static thrust stand data, and (3) fan calibration data. R.E.S.

N79-28143*# General Dynamics Corp. Fort Worth, Tex.
AERODYNAMIC CHARACTERISTICS OF FOREBODY AND NOSE STRAKES BASED ON F-16 WIND TUNNEL TEST EXPERIENCE. VOLUME 1: SUMMARY AND ANALYSIS Final Report, 1 Sep. 1977 - 30 Sep. 1978
C. W. Smith, J. N. Ralston, and H. W. Mann Jul. 1979 145 p refs
(Contract NAS1-15006)
(NASA-CR-3053) Avail: NTIS HC A07/MF A01 CSCL 01A

The YF-16 and F-16 developmental wind tunnel test program was reviewed. Geometrical descriptions, general comments, representative data, and the initial efforts toward the development of design guides for the application of strakes to future aircraft are presented. R.E.S.

N79-28144# Aeronautical Research Labs., Melbourne (Australia).
LONGITUDINAL AERODYNAMICS EXTRACTED FROM FLIGHT TESTS USING A PARAMETER ESTIMATION METHOD
R. A. Feik Oct. 1978 33 p refs
(ARL/Aero-Note-379; AR-001-308) Avail: NTIS HC A03/MF A01

Flight data from a 60 deg delta wing fighter aircraft were analyzed using a modified Newton-Raphson parameter estimation procedure. The model equations used for the analysis were extended to account for incidence vane errors and non-linearities in the pitching moment curves. Longitudinal derivatives extracted from the data have been compared with wind tunnel measurements and some theoretical estimates and areas of agreement and disagreement identified. The results demonstrate the usefulness of the parameter identification method, not only for the validation of aircraft mathematical models and for checking flight results against wind tunnel data, but also for obtaining aerodynamic data not easily available through other means. A.R.H.

N79-28145# Indian Inst. of Tech., Bombay. Dept. of Aeronautical Engineering.
APPLICATION OF VORTEX LATTICE METHOD FOR THE EVALUATION OF THE AERODYNAMIC CHARACTERISTICS OF WINGS WITH AND WITHOUT STRAKES M.S. Thesis

Jatinder Singh 1979 114 p refs
Avail: NTIS HC A06/MF A01

Wings characterized by small aspect ratio and large leading-edge sweep exhibit separation along leading-edge and side-edge. Well defined vortex over leading-edge and side-edge gives rise to incremental vortex lift. The aerodynamic characteristics of more generalized planforms incorporating incremental vortex lift are determined by using vortex lattice method to calculate the aerodynamic characteristics for potential flows. The effects of the leading edge vortex, tip vortices, and the detached leading edge and side edge vortices over the lifting surface are considered. A flow chart and input parameters for wings with and without strakes are given for a program calculating the aerodynamic characteristics of a planar wing in symmetric flight in an incompressible flow. Predicted values are compared with experimental results. A.R.H.

N79-28146*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
WING AERODYNAMIC LOADING CAUSED BY JET-INDUCED LIFT ASSOCIATED WITH STOL-OTW CONFIGURATIONS
U. vonGlahn and D. Groesbeck 1979 40 p refs Presented at Atmospheric Flight Mech. Conf., Boulder, Colo., 6-8 Aug. 1979; sponsored by AIAA
(NASA-TM-79218; E-110) Avail: NTIS HC A03/MF A01 CSCL 01A

Surface pressure distributions were obtained with model-scale STOL-OTW configurations using various nozzles designed to promote flow attachment to the wing/flap surface. The nozzle configurations included slot-types and both circular and slot nozzles with external flow deflectors. The wing aerodynamic loading caused by the jet-induced lift is presented in conventional terms of delta p/q as a function of chordwise surface distance in the nozzle centerline plane as well as outboard of the nozzle centerline. Nozzle roof/deflector angle, chordwise location of the nozzle, wing size, and flap deflection angle are included in the geometric variables affecting the wing loading. A.R.H.

N79-28149# Auburn Univ., Ala. Dept. of Aerospace Engineering.
AN AERODYNAMIC ANALYSIS OF DEFORMED WINGS IN SUBSONIC AND SUPERSONIC FLOW Interim Report, Jan. - Dec. 1978
John E. Burkhalter, Milton E. Vaughn, Jr., and John M. Abernathy Mar. 1978 54 p refs
(Grant DAAG29-78-G-0036)
(AD-A067586) Avail: NTIS HC A04/MF A01 CSCL 20/4

The aerodynamic loading for deformed wings in both subsonic and supersonic flow has been under study for the past year. The basic solution technique falls into the potential flow category with appropriate restrictions. A lifting surface kernel function formulation is used for both subsonic and supersonic flow and results are obtained which agree very well with experimental data. Subsonic solutions for deformed wings with deflected elevons are obtained in a semi-closed form summation manner. Cases under study which include gaps between the elevon wings are as yet incomplete but are presently being pursued. For supersonic flow, a modified Evvard solution forms the basis for the planar wing cases and vorticity paneling is added to account for local deformations in the wing mean camber surface. Results are obtained which agree very well with experimental data. The gapped elevon cases for supersonic flow is also analyzed and preliminary results have identified thickness effect, as being very important, at least for small elevon deflections. Author (GRA)

N79-28156# Massachusetts Inst. of Tech., Cambridge. Fluid Dynamics Research Lab.
AN OFF DESIGN SHOCK CAPTURING FINITE DIFFERENCE APPROACH FOR CARET WAVERIDER CONFIGURATIONS Final Report, 1 Apr. 1977 - 31 Dec. 1978
Judson R. Baron and I. Efrat Feb. 1979 96 p refs
(Contract F49620-77-C-0090; AF Proj. 2307)
(AD-A068819; AFOSR-79-0517TR) Avail: NTIS HC A05/MF A01 CSCL 20/4

The three dimensional off design flow fields are calculated for stream Mach numbers in the range 1.3 to 4.0 and corresponding to attached and detached shocks at the leading edges of a reentrant pyramidal waverider geometry. The MacCormack shock capturing version of the Lax-Wendroff finite difference technique is used with grids chosen to align with surface, symmetry and approximate shock traces in the transverse plane. Separate natural grid systems are defined for the compression and expansion regions, and an alternating region algorithm is used in combination with a sequential transfer of the edge region boundary conditions. The latter are derived from overlapping portions of the computational grids as integration proceeds axially to an asymptotic conical field. Equivalent attached shock cases result from either of two approaches: the alternating region algorithm, or a consideration of sólely the compression region with uniform unknown conditions assumed near the edges. For detached shock cases overall lift and drag coefficients exhibit smooth variations between the attached edge and detached apex limits. GRA

N79-28157# California Inst. of Tech., Pasadena. Div. of Engineering and Applied Science.
UNSTEADY SMALL-GAP GROUND EFFECTS
E. O. Tuck Mar. 1979 47 p
(Contract N00014-76-C-0157; NR Proj. 062-230)
(AD-A068400; E-97B-54) Avail: NTIS HC A03/MF A01 CSCL 20/4

Fluid-dynamic problems involving bodies moving close to walls are of interest in many different contexts, and there is a considerable literature dealing with such problems. The present paper concerns itself with phenomena which can be treated on an inviscid-fluid basis, and hence has little connection with the important branch of that literature dealing with low-Reynolds-number wall effects. The small-gap regime is defined, formally, as that in which the clearance is small compared to the horizontal length scale. Flow induced by a body moving near a plane wall is analysed on the assumption that the normal distance from the wall of every point of the body is small compared to the body length. The flow is irrotational except for the vortex sheet representing the wake. The gap-flow problem in the case of unsteady motion is reduced to a nonlinear first-order ordinary differential equation in the time variable. Problems solved include airfoil starting flows and their transient wakes, and flat plates falling toward the ground. GRA

N79-28158*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
POTENTIAL APPLICATIONS OF ADVANCED AIRCRAFT IN DEVELOPING COUNTRIES
Dal V. Maddalon Jul. 1979 43 p refs
(NASA-TM-80133) Avail: NTIS HC A03/MF A01 CSCL 01C

Air transportation concepts for movement of cargo in developing countries are reviewed using aicraft which may appear in the future. For certain industrial applications, including mining and forestry, the relative costs of doing the job using different types of aircraft are compared with surface transportation systems. Two developing countries, Brazil and Indonesia, were taken as examples to determine what impact they might have on the aircraft markets of the future. Economic and demographic data on developing countries in general, and Brazil and Indonesia in particular, are reviewed. The concept of an industrial city in a remote area developed around an airport is discussed. It is noted that developing areas generally lack extensive surface transportation systems and that an air transportation system can be implemented in a relatively short time. A developing nation interested in rapid expansion may thus find the role of air cargo far more important than has been true in developed nations. Technological developments which may dramatically increase the performance of agricultural aircraft are also reviewed. Author

N79-28160# Civil Aeromedical Inst., Oklahoma City, Okla.
INJURIES IN AIR TRANSPORT EMERGENCY EVACUATIONS
Donell W. Pollard Feb. 1979 32 p refs
(AD-A069372; FAA-AM-79-6) Avail: NTIS HC A03/MF A01 CSCL 01/2

Twelve air transport evacuations are reviewed. Injuries are discussed with emphasis on configurational and procedural contributing factors. Recommendations and information about possible methods of reducing injuries are provided. Author

N79-28161# University of Northern Illinois, De Kalb. Dept. of Biological Sciences.
DEVELOPMENT OF COMPUTER-GENERATED PHENOGRAMS TO FORECAST REGIONAL CONDITIONS HAZARDOUS TO LOW-FLYING AIRCRAFT Interim Report, 30 Sep. 1977 - 30 Sep. 1978
William E. Southern 15 Nov. 1978 219 p refs
(Grant AF-AFOSR-3431-77; AF Proj. 2312)
(AD-A068812; AFOSR-79-0611TR) Avail: NTIS HC A10/MF A01 CSCL 01/2

The seasonal distribution of all North American gull species as derived from banding data and Christmas Bird Count reports is presented. The proportion of each month's gull population is shown for 6 square Zones designated by latitude and longitude. The number of birds present per Zone is plotted therein according to Quadrants (= 1/4 Zone). USAF bird strikes occurring during 1974-1977 also are mapped for comparison. This preliminary summary of gull distribution and strike data can be used to identify when and where gulls may be presenting a significant hazard to low-flying aircraft. Application of the information during flight planning could reduce the number of strikes caused by gulls. Continuing studies will attempt to refine the application of such bird data to predict hazard levels to aircraft. GRA

N79-28162 Ohio State Univ., Columbus.
A STUDY OF ALTIMETER-CONTROLLED TERRAIN-FOLLOWING SYSTEMS Ph.D. Thesis
Donald Morris Sovine 1979 210 p
Avail: Univ. Microfilms Order No. 7916028

The probability of crashing (or clobbering), of P sub c was estimated. The techniques for the estimation of P sub c are accurate when applied to a linear vehicle with synthetically generated terrain as an input. When both real and simulated terrain is the input to a nonlinear vehicle model, the results are similar; however, occasionally large errors occur that are not predicted by the theory. Similar errors are also apparent when real terrain is the input to the linear vehicle model, an indication that anomalous terrain behavior as well as certain characteristics of the limiters may be pronounced contributors to P sub c. It is concluded that the theory is an excellent tool for system design but that an alternate technique is desirable for accurate selection of the required clearance altitudes for an actual flight vehicle. Dissert. Abstr.

N79-28165# Naval Air Rework Facility, Norfolk, Va.
PACIFIC AREA EVALUATION OF A COMMERCIAL OMEGA NAVIGATION SYSTEM INSTALLED IN A VC-118 AIRCRAFT, SUPPLEMENT 1
Clifton G. Wrestler, Jr. 10 Apr. 1979 9 p
(AD-A068106; NARF-C-118-WSM-1-78-Suppl-1) Avail: NTIS HC A02/MF A01 CSCL 17/7

A supplemental evaluation was deemed necessary for the Pacific Area due to variations in the geographic locations and power output of the ground based transmitters. GRA

N79-28166# Army Engineer Topographic Labs., Fort Belvoir, Va.
ANALYSIS, STORAGE, AND RETRIEVAL OF ELEVATION DATA WITH APPLICATIONS TO IMPROVE PENETRATION Research Note
Allen Klinger Mar. 1979 21 p refs
(AD-A068747; ETL-0179) Avail: NTIS HC A02/MF A01 CSCL 17/7

A method to use terrain elevation data for guidance is presented. Tree structure representation of contour trend data over regions is the basis of the method. Regions of different sizes obtained by quartering given elevation matrices are used; region size corresponds to tree position. Two computer functions are discussed: analysis methods to use tree-structured contour-trend information, suitable for onboard inflight computations; and storage reduction methods to present elevation data as a new digital mapping product (tree-structured contour-trend data), computable off-line on the USAETL Computer Sciences Laboratory STARAN array processor. Six figures detailing the analytic and data storage concepts discussed are given. An example illustrating the improved penetration possible from these methods is presented. GRA

N79-28168*# McDonnell-Douglas Corp., St. Louis, Mo.
HYPERSONIC AIRFRAME STRUCTURES: TECHNOLOGY NEEDS AND FLIGHT TEST REQUIREMENTS Final Report
J. E. Stone and L. C. Koch Jul. 1979 134 p refs
(Contract NAS1-14924)
(NASA-CR-3130; MDC-A4839) Avail: NTIS HC A07/MF A01 CSCL 01C

Hypersonic vehicles, that may be produced by the year 2000, were identified. Candidate thermal/structural concepts that merit consideration for these vehicles were described. The current status of analytical methods, materials, manufacturing techniques, and conceptual developments pertaining to these concepts were reviewed. Guidelines establishing meaningful technology goals were defined and twenty-eight specific technology needs were identified. The extent to which these technology needs can be satisfied, using existing capabilities and facilities without the benefit of a hypersonic research aircraft, was assessed. The role that a research aircraft can fill in advancing this technology was discussed and a flight test program was outlined. Research aircraft thermal/structural design philosophy was also discussed. Programs, integrating technology advancements with the projected vehicle needs, were presented. Program options were provided to reflect various scheduling and cost possibilities. R.E.S.

N79-28169# Bell-Northern Research Ltd., Ottawa (Ontario).
ELECTROMAGNETIC COMPATIBILITY (EMC) INVESTIGATION ON CH147 CHINOOK HELICOPTER
R. R. Goulette and K. E. Felske Jan. 1979 54 p
(Contract DNF-2pb77-00186; AETE Proj. 77/16-4)
(Rept-5J30-4479-02; DSS-3PB-2127662) Avail: NTIS HC A04/MF A01

The findings of the electromagnetic compatibility investigation performed on the CH147 Chinook helicopter, fitted with a high intensity anticollision strobe light, a crash position indicator, and an Omega navigation system are presented. R.E.S.

N79-28170# United Technologies Corp., Stratford, Conn. Sikorsky Aircraft Div.
ESTABLISHMENT OF MANUFACTURING METHOD AND TECHNOLOGY FOR THE FABRICATION OF HELICOPTER MAIN ROTOR BLADE SPARS BY CONTINUOUS SEAM DIFFUSION BONDING TITANIUM SHEET MATERIAL Final Report, 1 Oct. 1975 - 30 Sep. 1978
Maron J. Bonassar and John L. Lucas Nov. 1978 169 p refs
(Contract DAAG46-76-C-0016)
(AD-A067590; SER-510010; AVRADCOM-TR-79-5; AMMRC-TR-78-50) Avail: NTIS HC A08/MF A01 CSCL 13/8

This report summarizes a series of U.S. Army sponsored Manufacturing Methods and Technology, MM and T programs which were ultimately aimed at evaluating and implementing into production the use of the Continuous Seam Diffusion Bonding, CSDB, process to fabricate reliable, lower cost titanium alloy 6Al-4V helicopter main rotor blade spars. The current production process for manufacturing the UH-60A Army Black Hawk helicopter main rotor blade spars uses a plasma arc weld to join a cold brake formed cylindrical shape titanium sheet pre-form. The titanium pre-form is subsequently creep formed to the required final contour. The subject program has investigated and fabricated various shape spar pre-forms and manufacturing operations that could be easily cold brake formed from flat titanium sheet material into a configuration that is capable of being continuous seam diffusion bonded and subsequently creep formed to the final contour. Tooling which is capable of clamping and satisfactorily bonding the selected configuration pre-form shape has been designed and constructed. Process parameters relating to bonding variables and material condition have been evaluated. The subject program has successfully diffusion bonded three, ten foot length BLACK HAWK spar tubes, and non-destructively inspected, NDI, ten bonded spar tubes for any abnormalities. GRA

N79-28171# Army Test and Evaluation Command, Aberdeen Proving Ground, Md.
INTERNAL/EXTERNAL LIGHTING (AVIATION MATERIEL) Final Report
Oct. 1978 33 p refs Supersedes MTP-7-3-527
(AD-A068951; TOP-7-3-527; MTP-7-3-527) Avail: NTIS HC A03/MF A01 CSCL 01/3

This TOP establishes the procedure to conduct a developmental test of an internal and/or external lighting system as well as illumination test of a single or multiple instruments set or any other special purpose light or lights associated with the aircraft operational capability or crew performance, including troop and cargo compartment lighting. The aircraft light or lighting system will be operated during all applicable aircraft operational phases and assessed under all applicable atmospheric and climatic conditions representative of the operational environment the aircraft is expected to see within its operational theater. The primary objectives of this TOP are: (1) to determine if the designated light or lighting system performs its intended function in accordance with the requirements presented in the applicable approved documents; Letter of Requirement (LR), Letter of Agreement (LOA), Required Operational Characteristics (ROC), etc., as reflected through the detailed Test Design Plan (TDP); (2) to establish any detrimental or compromising side effects; (3) to insure human factors criteria have been met; and (4) to determine if the designated light or lighting system conforms to the applicable military specifications and/or standards as well as system specifications. GRA

N79-28175# Calspan Corp., Buffalo, N. Y.
AN EXPERIMENTAL INVESTIGATION OF CONTROL-DISPLAY REQUIREMENTS FOR A JET-LIFT VTOL AIRCRAFT IN THE TERMINAL AREA Final Report, Jun. 1976 - Jul. 1978
J. V. Lebacqz, R. C. Radford, and J. L. Beilman Jul. 1978 399 p refs
(Contract N62269-76-C-0370)
(AD-A068818; CALSPAN-AK-5985-F-1) Avail: NTIS HC A05/MF A01 CSCL 01/3

The fourth flight research program using the variable stability, variable display X-22A VTOL research aircraft was undertaken with the objective of expanding the operational capability of VTOL aircraft under adverse weather conditions. The experiment investigated a matrix of control, display and task variables for the landing approach task in a ground simulation phase followed by an in-flight simulation phase. Aerodynamic characteristics of the McDonnell-Douglas AV-8B Advanced Harrier were simulated for a prescribed decelerating approach profile using the X-22A's variable stability system; around this simulation, an analog of the AV-8B control system was implemented to investigate a range of realizable control system designs. Combinations of these control concepts and a variety of head-up display formats and information levels were evaluated in fight for simulated instrument approaches. GRA

N79-28176*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
A THROAT-BYPASS STABILITY-BLEED SYSTEM USING RELIEF VALVES TO INCREASE THE TRANSIENT STABILITY OF A MIXED-COMPRESSION INLET
George H. Neiner, Miles O. Dustin, and Gary L. Cole Jul. 1979 47 p refs
(NASA-TP-1083; E-8950) Avail: NTIS HC A03/MF A01 CSCL 21E

A stability-bleed system was installed in a YF-12 flight inlet that was subjected to internal and external airflow disturbances in the NASA Lewis 10 by 10 foot supersonic wind tunnel. The purpose of the system is to allow higher inlet performance while maintaining a substantial tolerance (without unstart) to internal and external disturbances. At Mach numbers of 2.47 and 2.76, the inlet tolerance to decreases in diffuser-exit corrected airflow was increased by approximately 10 percent of the operating-point airflow. The stability-bleed system complemented the terminal-shock-control system of the inlet and did not show interaction problems. For disturbances which caused a combined decrease in Mach number and increase in angle of attack, the system with valves operative kept the inlet started 4 to 28 times longer than with the valves inoperative. Hence, the stability system provides additional time for the inlet control system to react and prevent unstart. This was observed for initial Mach numbers of 2.55 and 2.68. For slow increase in angle of attack at Mach 2.47 and 2.76, the system kept the inlet started beyond the steady-state unstart angle. However, the maximum transient angles of attack without unstart could not be determined because wind-tunnel mechanical-stop limits for angle of attack were reached. A.R.H.

N79-28177*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECT OF ROTOR MERIDIONAL VELOCITY RATIO ON RESPONSE TO INLET RADIAL AND CIRCUMFERENTIAL DISTORTION
Nelson L. Sanger Jul. 1979 73 p refs
(NASA-TP-1278; E-8987) Avail: NTIS HC A04/MF A01 CSCL 21E

Three single transonic fan stages, each having a different meridional velocity ratio across its rotor, were tested with two magnitudes of tip radial distortion and with a 90 deg circumferential distortion imposed on the inlet flow. The rotor with the lowest meridional velocity ratio (less than 0.9 at the tip) demonstrated the least degradation of performance due to these distortions. Loss and deviation angle data (as needed for performance prediction with radial distortion) calculated along actual streamlines for radially distorted flow and correlated against diffusion factor, showed consistent agreement with data calculated along design streamlines for undistorted flow. Author

N79-28178# Monsanto Research Corp., Dayton, Ohio.
JET ENGINE EXHAUST ANALYSIS BY SUBTRACTIVE CHROMATOGRAPHY Final Report, 1 Mar. 1977 - 24 Jul. 1978
Joseph J. Brooks, Diana S. West, John E. Strobel, and Leonard Stamper Dec. 1978 77 p refs
(Contract F33615-77-C-0616)
(AD-A067898; MRC-DA-839; SAM-TR-78-37) Avail: NTIS HC A05/MF A01 CSCL 21/2

This report describes the further refinement of a method for the sampling and analysis of organics in jet engine exhaust by chemical classes. Details for the selection, construction, and evaluation of the combination sorbent (Tenax-GC/Ambersorb XE-340) sampling system are given along with the rationale and operational parameters for the subtractive chromatography system that produces the organic class analysis. The significant improvements incorporated into both the sampling and analytical systems compared with previous systems used in a jet engine exhaust study of March 1975 are discussed. The capabilities of the system are illustrated by the analysis of actual jet engine exhaust samples from a J85-5 engine using JP-4 and an alternate fuel blend that simulates the higher aromatic content expected from shale and coal-derived fuels. Author (GRA)

N79-28179# Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio.
BUILD 1 OF AN ACCELERATED MISSION TEST OF A TF41 WITH BLOCK 76 HARDWARE Final Report, 18 Oct. 1977 - 13 Jan. 1978
Robert J. May, Jr., Donald P. Mcerlean, and Doretta Holland Mar. 1979 191 p refs
(AD-A068595; AFAPL-TR-79-2020) Avail: NTIS HC A09/MF A01 CSCL 21/5

An accelerated mission test (AMT) of a TF41 (S/N 142163) was conducted in the Air Force Aero Propulsion Laboratory's 'D' bay sea level engine test facility between 18 Oct 77 and 13 Jan 78. The primary objective of the test was to evaluate the structural reliability of a series of parts changes known as 'Block 76' hardware under realistic usage conditions. A two hundred sixty three hour test program was initially planned but only one hundred and six hours were actually completed due to the failure of a second stage high pressure turbine blade. The second stage turbine had been reworked and the verification of this rework scheme was a secondary objective of this test. The failure occurred at a reworked location but the actual cause of failure could not be determined. The post-test teardown inspection showed all of the Block 76 hardware to be in good condition. GRA

N79-28181# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
TECHNICAL EVALUATION REPORT ON THE 52ND SYMPOSIUM OF THE PROPULSION AND ENERGETICS ON STRESSES, VIBRATIONS, STRUCTURAL INTEGRATION AND ENGINE INTEGRITY (INCLUDING AEROELASTICITY AND FLUTTER)
L. Beitch (Gen. Elec. Co., Evandale, Ohio) Mar. 1979 12 p refs Symp. held in Cleveland, Ohio, 23-27 Oct. 1978
(AGARD-AR-133; ISBN-92-835-1314-2) Avail: NTIS HC A02/MF A01

A wide spectrum of topics associated with engine development, engine-aircraft integration, and engine operation were addressed. M.M.M.

N79-28182 California Univ., Los Angeles.
IDENTIFICATION OF AIRCRAFT PARAMETERS IN TURBULENCE WITH NON-RATIONAL SPECTRAL DENSITY Ph.D. Thesis
Frank Chu-Chun Tung 1979 171 p
Avail: Univ. Microfilms Order No. 7915685

Aircraft turbulence was modeled with the von Karman spectrum in an attempt to improve the aircraft parameter estimation method. A new identification technique was introduced to handle linear systems with non-rational transfer functions, and the associated numerical methods were also developed. This new technique was then applied to both simulated and actual flight test data. Dissert. Abstr.

N79-28183 Illinois Univ. at Urbana-Champaign.
EFFECT OF ATMOSPHERIC TURBULENCE ON THE STABILITY OF A LIFTING ROTOR BLADE Ph.D. Thesis
Yoshinori Fujimori 1978 200 p
Avail: Univ. Microfilms Order No. 7913462

Motion stability of a lifting rotor blade operating in a turbulent flow is investigated. A new procedure is developed in which use is made of the Markov process theory and numerical solution of the Floquet transition matrix and its eigenvalues. The basic differential equations governing the flap, flap-torsion and flap-leadlag motions are first linearized and then converted into corresponding stochastic differential equations in the sense of Ito. For simplicity, all parametric excitations are assumed to be of the white noise type with constant spectral densities. The equations for the first and second moments are derived from the Ito equations. Since both the first and second moment equations are differential equations with periodic coefficients, the stability boundary in each case is found by a numerical search involving the determination of the Floquet transition matrix and its eigenvalues. Numerical examples are given to illustrate the application of the theory. Dissert. Abstr.

N79-28185 Ohio State Univ., Columbus.
THEORY, DESIGN AND EXPERIMENTAL STUDY OF AN EDDY-CURRENT/HYDROMECHANICAL STABILITY AUGMENTOR FOR AIRCRAFT Ph.D. Thesis
Gavin Dale Jenney 1979 248 p
Avail: Univ. Microfilms Order No. 7915991

The hydromechanical eddy-current coupler mechanization described consists of an inertial reference, an eddy-current coupler, and a hydraulic actuator controlled by a flapper-nozzle hydraulic control stage. The inertial reference incorporates permanent magnets mounted on a support disc which is pivoted with instrument bearings at its geometric center. The magnets are the principal mass of the inertial reference. The calculations and experimental test results used for the design of the experimental unit are presented. The unit was tested at 80 F and -40 F fluid temperatures and met the objectives of providing the desired performance with less hydraulic flow. The total actuator weight and size are equivalent to or less than prior mechanizations. Dissert. Abstr.

N79-28187# Army Engineer Waterways Experiment Station, Vicksburg, Miss. Geotechnical Lab.
DEVELOPMENT OF A STRUCTURAL DESIGN PROCEDURE FOR RIGID AIRPORT PAVEMENTS Final Report, 1975 - 1978
Frazier Parker, Jr., Walter R. Barker, Robert C. Gunkel, and Eugene C. Odom Apr. 1979 299 p refs
(Contract DOT-FA73WAI-377; DA Proj. 4A1-61102-B-52E)
(AD-A069548; WES-TR-GL-79-4; FAA-RD-77-81) Avail: NTIS HC A13/MF A01 CSCL 01/5

The development and formulation of a design procedure for rigid airport pavements are presented. The design criteria used in the procedure are based on the tensile stress in the portland cement concrete (PCC) slab as computed by layered elastic theory and the strength of the PCC slab as measured in the flexural beam test. The criteria were developed by the analysis of some 60 test sections. Procedures are given for the characterization of the pavement materials both by laboratory testing and by typical values and/or correlation studies. The thickness requirements as determined by the new criteria are compared with the thickness as determined by present Corps of Engineers-Federal Aviation Administration design procedures. Author

N79-28188# Federal Aviation Administration, Washington, D. C. Office of Management Systems.
FAA AIR TRAFFIC ACTIVITY, FISCAL YEAR 1978
Patricia Wilson 30 Sep. 1978 238 p
(AD-A067910) Avail: NTIS MF A01; HC SOD $4.50 CSCL 01/2

This report furnishes terminal and enroute air traffic activity information of the National Airspace System. The data have been reported by the FAA-operated Airport Traffic Control Towers (ATCTs), Air Route Traffic Control Centers (ARTCCs), Flight Service Stations (FSSs), Combined Station Towers (CS/Ts), International Flight Service Stations (IFSSs), and Approach Control Facilities. Author (GRA)

N79-28189# Air Force Engineering and Services Center, Tyndall AFB, Fla. Engineering and Services Lab.
INTERIM FIELD PROCEDURE FOR BOMB DAMAGE REPAIR USING CRUSHED LIMESTONE FOR CRATER REPAIRS AND SILIKAL TRADE NAME FOR SPALL REPAIRS Interim Report, Jun. 1978 - Mar. 1979
Michael T. McNerney Apr. 1979 52 p refs
(AF Proj. 2104)
(AD-A068617; AFESC/ESL-TR-79-01) Avail: NTIS HC A04/MF A01 CSCL 19/4

This report describes a recommended procedure for performing repairs of large and small bomb craters using crushed stone as the repair material. The report also describes a rapid spall repair technique using a proprietary polymer concrete product. The repair techniques are described to determine the equipment, manpower, and time required to affect repairs. The report gives a brief description of the results of field tests using the crushed stone and polymer concrete techniques. GRA

N79-28190# General Accounting Office, Washington, D. C. Community and Economic Development Div.
DEVELOPING A NATIONAL AIRPORT SYSTEM: ADDITIONAL CONGRESSIONAL GUIDANCE NEEDED Report to the Congress
17 Apr. 1979 75 p refs
(PB-294082/3; CED-79-17) Avail: NTIS HC A04/MF A01 CSCL 01E

In the next decade, over $10 billion will be needed to develop a national airport system. Of this, about $3 billion is needed to develop some 2,600 general aviation airports to serve business and pleasure flying. Additional congressional guidance is needed to help identify general aviation airports essential to a national airport system. State and local airport planning financed with Federal grants was to support development of the national airport system; this has not occurred. Federal legislation should be enacted to require State and local airport plans as a prerequisite for Federal airport development grants. Sufficient grant funds have not been available to finance airport improvements. The existing method for funding such improvements has not been effective in implementing a national airport system. The Congress should establish priorities for distributing Federal airport development grants. GRA

N79-28232* Boeing Commercial Airplane Co., Seattle, Wash.
ENVIRONMENTAL EXPOSURE EFFECTS ON COMPOSITE MATERIALS FOR COMMERCIAL AIRCRAFT
Daniel J. Hoffman Aug. 1978 49 p refs
(Contract NAS1-15148)
(NASA-CR-158838; D6-44815-3; QPR-3) Avail: NTIS HC A03 CSCL 11D

Activities reported include completion of the program design tasks, resolution of a high fiber volume problem and resumption of specimen fabrication, fixture fabrication, and progress on the analysis methodology and definition of the typical aircraft environment. Program design activities including test specimens, specimen holding fixtures, flap-track fairing tailcones, and ground exposure racks were completed. The problem experienced in obtaining acceptable fiber volume fraction results on two of the selected graphite epoxy material systems was resolved with an alteration to the bagging procedure called out in BAC 5562. The revised bagging procedure, involving lower numbers of bleeder plies, produces acceptable results. All required laminates for the contract have now been laid up and cured. Progress in the area of analysis methodology has been centered about definition of the environment that a commercial transport aircraft undergoes. The selected methodology is analagous to fatigue life assessment. A.R.H.

N79-28235*# Rensselaer Polytechnic Inst., Troy, N. Y.
COMPOSITE STRUCTURAL MATERIALS Semiannual Progress Report, Oct. 1978 - Apr. 1979
George S. Ansell, Robert G. Loewy, and Stephen E. Wiberly Jul. 1979 130 p Sponsored jointly by NASA and AFOSR
(Grant NGL-33-018-003)
(NASA-CR-158851; SAPR-36) Avail: NTIS HC A07/MF A01 CSCL 11D

Technology utilization of fiber reinforced composite materials is discussed in the areas of physical properties, and life prediction. Programs related to the Composite Aircraft Program are described in detail. R.E.S.

N79-28238# McDonnell Aircraft Co., St. Louis, Mo.
BOLTED FIELD REPAIR OF COMPOSITE STRUCTURES Final Report, 27 Sep. 1977 - 30 Sep. 1978
James B. Watson, D. A. Glaeser, F. L. Harvey, W. T. Fukimoto, and V. E. Padilla 1 Mar. 1979 212 p refs
(Contract N62269-77-C-0366)
(AD-A067923; MDC-A5583; NADC-77109-30) Avail: NTIS HC A10/MF A01 CSCL 11/2

Mechanically fastened, field repairs for graphite/epoxy laminates 3/16 and 1/2 inch thick with through-the-thickness hole damage have been successfully demonstrated. These repairs (titanium alloy patches and backing plates) were developed for application on fuel cell composite wing surfaces and can be installed by maintenance personnel in the field using available equipment, materials, and methods. A total of 28 specimens were fabricated and tested statically to evaluate effectiveness of selected repair designs. GRA

N79-28245# Naval Air Development Center, Warminster, Pa. Aircraft and Crew Systems Technology Directorate.
INFLUENCE OF JET FUEL ON PERMEATION AND FLAMMABILITY CHARACTERISTICS OF GRAPHITE EPOXY COMPOSITES
Lourdes C. Fuller, David A. Lutz, and Edward R. Wright 21 Feb. 1979 26 p
(WF41400000)
(AD-A068586; NADC-79022-60) Avail: NTIS HC A03/MF A01 CSCL 11/4

Graphite epoxy composites were subjected to controlled studies of fuel permeation, fuel immersion and flammability in an effort to judge their safety and effectiveness as a material for use in jet fuel tanks. GRA

N79-28329# Dow Corning Corp., Midland, Mich.
FASIL INTEGRAL FUEL TANK SEALANTS, PART 1 Final Report, Sep. 1977 - Sep. 1978
O. R. Pierce, K. M. Lee, K. Rossknecht, and A. H. McHale Jan. 1979 40 p refs
(Contract F33615-77-C-5139)
(AD-A067889; AFML-TR-79-4009-Pt-1) Avail: NTIS HC A03/MF A01 CSCL 11/9

The objective of this three year program is the synthesis, formulation, and evaluation of fasil (fluoroalkylarylene-siloxanylene) copolymers as curing and non-curing seals for fuel containment in high performance aircraft. This portion of the program was concerned primarily with the synthesis of monomers but a brief examination of selected polymerization systems was also conducted. Polymers containing the silphenylene structure have attracted the attention of a number of workers over the past twenty years because their thermooxidative stability is superior to that of (Me2SiO)x. Copolymers of silphenylenes and dimethylpolysiloxanes were envisioned as materials possibly possessing the desirable properties of both parent systems and this was realized to a certain extent. Thus incorporating silphenylene units into polydimethylsiloxane decreases the tendency to split out cyclic oligomers in a hot environment but raises the Tg because silphenylene tends to be crystalline. GRA

N79-28367 Technical Univ. of Denmark, Lyngby. Dept. of Machine Elements.
EVALUATION OF STIFFNESS AND DAMPING COEFFICIENTS FOR FLUID-FILM BEARINGS
J. W. Lund *In* Shock and Vibration Inform. Center Shock and Vibration Dig., Vol. 11, No. 1 Jan. 1979 p 5-10 refs

Avail: SVIC, Code 8404, Naval Research Laboratory, Washington, D. C. 20375; $15.00/set

Methods for calculating fluid film bearing stiffness and damping coefficients are briefly described. Restrictions imposed by such assumptions as linearity are evaulated. Experimental methods used to obtain data necessary to determine the coefficients are presented. Author

N79-28372# Textron Bell Aerospace Co., New Orleans, La.
AALC FAN MODEL TEST PROGRAM Final Report, 15 May 1978 - 8 May 1979
J. L. Allison 8 May 1979 212 p refs
(Contract N00014-78-C-0493)
(AD-A069058; Rept-7575-927031) Avail: NTIS HC A10/MF A01 CSCL 13/9

A 12-inch-diameter centrifugal fan impeller, which was a model of an existing full-scale air cushion vehicle (ACV) fan impeller, was tested in five different volute configurations including one which modeled another existing full-scale ACV installation. It was shown that the suitably scaled impeller could serve as a replacement for the other full-scale craft fans. Numerous velocity and pressure surveys were performed, and their results are discussed. GRA

N79-28373# Textron Bell Aerospace Co., New Orleans, La.
A STUDY OF REQUIREMENTS, MODEL CONFIGURATIONS, AND TEST PLANS FOR AIR CUSHION SYSTEM COMPARISON TESTS Final Report, 15 Aug. 1978 - 14 May 1979
J. Ryken 14 May 1979 40 p refs
(Contract N00014-78-C-0588)
(AD-A069006; Rept-7575-953032) Avail: NTIS HC A03/MF A01 CSCL 13/10

The Navy plans to test several models of air cushion vehicles with different cushion systems. A set of model design requirements suitable for all the models was developed by the Navy with the assistance of Bell Aerospace Textron and other contractors. The proposed DTNSRDC Model Test Program was reviewed. Minor changes and additions were suggested. A preliminary model configuration using Bell cushion philosophy was proposed. Ranges of bag and cushion pressures and airflows were established for the model. Two existing model fans from an existing model of the AALC JEFF(B) could provide the required nominal flow and pressure. Bell recommends installing four of these existing fans to permit testing over a wide range of flows. Cost and schedule estimates for the model detail design and construction were prepared. The schedule is shown in this report; cost estimates were provided under separate cover. GRA

N79-28374# Aerojet Liquid Rocket Co., Sacramento, Calif.
ACV CUSHION COMPARISON TESTS: PRELIMINARY REVIEW AND DEFINITION OF MODEL AND TESTS Final Report
Apr. 1979 30 p
(Contract N00014-78-C-0739)
(AD-A068888; ALRC-LCAC-2299-002) Avail: NTIS HC A03/MF A01 CSCL 13/10

The prime objective of this cushion comparison program is to be able to obtain data on the various existing cushion systems, that can be compared directly in the context of the amphibious assault mission. The use of a series of scale models, built and tested to a common standard, will provide a means of obtaining basic performance data that can be compared directly. The model is to be a dynamically similar representation of an air cushion vehicle (ACV) designed to the requirements of the Navy's amphibious assault mission. The purpose of the model is to provide data for the comparison of cushion systems. A linear scale factor of 1/12 full scale for the model was selected. The features considered most important are flexible skirt that contains the cushion, the lift fan system and the lift air distribution system together with the general hull form. The amphibious assault lift ships, that are to carry the ACV's, impose strict limits on the major dimensions of the craft. These are to be reflected in the model. GRA

N79-28393# Ohio State Univ., Columbus. Electroscience Lab.
INFORMATION PROCESSING FOR TARGET DETECTION AND IDENTIFICATION Final Report
A. A. Ksienski Apr. 1979 15 p refs
(Grant AF-AFOSR-2611-74; AF Proj. 2304)
(AD-A068907; ESL-783815-8; AFOSR-79-0596TR) Avail: NTIS HC A02/MF A01 CSCL 17/9

This report summarizes the accomplishments attained under the grant. The goal was the development of automatic target classification techniques utilizing low frequency radar returns. Reliable classification techniques were developed and shown to be effective for a large variety of target shapes. In particular, a reliable performance has been shown for aircraft identification, where eight classes of combat planes, both American and foreign made, were tested. The problem of classifying an object as belonging or not belonging to a specified catalogue of classes was successfully solved and a simple and reliable implementation was devised. GRA

N79-28419*# ORI, Inc., Silver Spring, Md.
ADVANCED RISK ASSESSMENT OF THE EFFECTS OF GRAPHITE FIBERS ON ELECTRONIC AND ELECTRIC EQUIPMENT, PHASE 1 Final Report
Leon S. Pocinki, Lawrence D. Kaplan, Merrill E. Cornell, and Reynold Greenstone May 1979 217 p refs
(Contract NAS1-15379)
(NASA-CR-159027) Avail: NTIS HC A10/MF A01 CSCL 09C

A model was developed to generate quantitative estimates of the risk associated with the release of graphite fibers during fires involving commercial aircraft constructed with graphite fiber composite materials. The model was used to estimate the risk associated with accidents at several U.S. airports. These results were then combined to provide an estimate of the total risk to the nation. A.R.H.

N79-28456*# Detroit Diesel Allison, Indianapolis, Ind.
LASER ANEMOMETER MEASUREMENTS AT THE EXIT OF A T63-C20 COMBUSTOR Final Report, Sep. 1978 - Apr. 1979
D. B. Zimmerman Apr. 1979 44 p refs Sponsored in part by Army Research and Develop. Command, Cleveland
(Contract NAS3-21267; DA Proj. 1L1-62209-AH-76)
(NASA-CR-159623; DDA-RN-79-4) Avail: NTIS HC A03/MF A01 CSCL 20D

An experimental study of the flow downstream of a T63-C20 gas turbine engine combustor was performed. Laser anemometer measurements of the mean and fluctuating velocities were made in a combustion rig across an annulus simulating the inlet to turbine. A window design suitable for similar measurements in a gas turbine engine was made based on the results of this experiment. Insufficient numbers of naturally-occurring scattering particles were present in the flow. Hollow phenolic particles added to the flow provided adequate signal strength for measurement. For each of the simulated engine operating conditions of flight idle, 30% power and 90% power, both with and without the addition of fuel, the mean velocities and turbulent intensities were uniform across the annulus. The turbulent intensity was substantially unaffected by the addition of fuel but was apparently only dependent on the inlet flow condition at a given power point. Little or no swirl was present in the flow at the annulus. Author

N79-28474# Ruhr Univ., Bochum (West Germany). Inst. fuer Konstruktiven Ingenieurbau.
FINITE ELEMENT METHODS FOR INVISCID AND VISCOUS FLOW PROBLEMS
Guenter Schmid *In* Von Karman Inst. for Fluid Dyn. Computational Fluid Dyn., Vol. 1 1978 41 p refs

Avail: NTIS HC A18/MF A01

A survey of the basic features of the finite element method is made; their applications to fluid dynamics are discussed. Compressible flow is discussed for subsonic velocities only. Possible finite element procedures are considered for incompressible viscous flow. In the special case of creeping flow, alternative extremum principles are available, as in the case of potential flow, and simplify the derivation of finite elements. The various methods are listed together with their essential boundary conditions and their natural (weak) boundary conditions. Graphical examples are shown. Author (ESA)

N79-28475# British Aerospace Dynamics Group, Bristol (England). Military Aircraft Div.
THE PANEL METHOD FOR SUBSONIC AERODYNAMIC FLOW: A SURVEY OF MATHEMATICAL FORMULATIONS AND NUMERICAL MODELS WITH AN OUTLINE OF THE NEW BRITISH AEROSPACE SCHEME
B. Hunt *In* Von Karman Inst. for Fluid Dyn. Computational Fluid Dyn., Vol. 1 1978 70 p refs

Avail: NTIS HC A18/MF A01

A comprehensive description of the mathematical foundation of panel methods is given. An explanation of the basic errors inherent in most schemes, but manifested most dramatically for first order schemes employing an internal vortex lattice, is offered. The observation of certain guidelines makes it possible for first order schemes to compare with the accuracy of higher order schemes. Present capabilities and current developments are discussed. Least squares minimisation of source/vortex pseudo error on wing-type components is presented as an appendix. Author (ESA)

N79-28477# Institut de Recherche d'Informatique et d'Automatisme, Roquencourt (France).
APPLICATION OF A FINITE ELEMENT METHOD TO TRANSONIC FLOW PROBLEMS USING AN OPTIMAL CONTROL APPROACH
M. O. Bristeau *In* Von Karman Inst. for Fluid Dyn. Computational Fluid Dyn., Vol. 1 1978 50 p refs Sponsored by Direction des Rech. et Etudes Tech.

Avail: NTIS HC A18/MF A01

The least squares method is introduced as a general technique for solving nonlinear equations. The complexity of the geometries appearing in realistic applications of transonic equations entails the use of the finite element method as it is well suited to the discretization of these problems. The results obtained for nonlifting and lifting bodies show the validity of the method. Improvements are needed to reduce the computing time and some suggestions to this end are made. Author (ESA)

N79-28482# British Aerospace Dynamics Group, Bristol (England).
THE COMPUTATION OF VORTEX FLOWS BY PANEL METHODS
S. A. Jepps *In* Von Karman Inst. for Fluid Dyn. Computational Fluid Dyn., Vol. 2 1978 39 p refs Sponsored in part by Min. of Defence
Avail: NTIS HC A14/MF A01
Use of panel methods to calculate flows in which vorticity exists in the body of the fluid is discussed. Calculation of the vortex wake behind a lifting wing is described. The more difficult problem of computing free vortices which interact strongly with nearly solid surfaces is then considered. A hybrid technique combining a three-dimensional attached flow method with a slender body separated flow method is discussed using a delta wing as an example. Author (ESA)

N79-28555# Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).
OFF-DESIGN PERFORMANCE OF GAS TURBINES, VOLUME 1
1978 349 p refs Lectures held at Rhode-Saint-Genese, Belgium, 30 Jan. - 3 Feb. 1978 2 Vol.
(VKI-Lec-Ser-1978-2-Vol-1) Avail: NTIS HC A15/MF A01
The off-design performance of gas turbines is discussed in a series of lectures. Reviews of numerical analysis methods, computerized methods, stalling performance prediction, influence of particular variables, etc., are included.

N79-28556# Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Villaroche (France).
THE IMPORTANCE OF OFF-DESIGN OPERATION
Roger P. Bouillet *In* Von Karman Inst. for Fluid Dyn. Off-Design Performance of Gas Turbines, Vol. 1 1978 39 p

Avail: NTIS HC A15/MF A01
Contributing factors, component performance prediction methods, and overall performance prediction methods are reviewed. It is concluded that prediction of off-design performance is essential and that it must cover both steady and transient running performance. Author (ESA)

N79-28557# Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).
THE PREDICTION OF COMPRESSOR BLADE ROW PERFORMANCE: NUMERICAL METHODS AND THEORETICAL APPROACHES
R. vandenBraembussche *In its* Off-Design Performance of Gas Turbines, Vol. 1 1978 93 p refs

Avail: NTIS HC A15/MF A01
The present status of prediction methods for fluid mechanics in turbomachines is reviewed. The substitution of analytical methods by numerical methods applicable to more complex geometries is discussed. Author (ESA)

N79-28558# Brown, Boveri and Co., Ltd., Baden (Switzerland).
A THREE DIMENSIONAL FLOW COMPUTING SYSTEM APPLICABLE TO AXIAL AND RADIAL FLOW TURBOMACHINES
M. Ribaut *In* Von Karman Inst. for Fluid Dyn. Off-Design Performance of Gas Turbines, Vol. 1 1978 44 p refs

Avail: NTIS HC A15/MF A01
The justification for and application to examples of a potential method are presented. Current interest in the method due to its simplicity and accuracy is noted. Calculations are described including the calculation of the velocity field on a surface of revolution, the calculation of an axisymmetric solution, and the description of the effects of the three variables describing the velocity field, that is boundary surface, viscosity, and compressibility of the fluid. Graphic examples of applications are given. ESA

N79-28560# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
UNSTABLE FLOW REGIMES, INCLUDING ROTATING STALL, SURGE, DISTORTIONS, ETC.
J. Fabri *In* Von Karman Inst. for Fluid Dyn. Off-Design Performance of Gas Turbines, Vol. 1 1978 22 p refs

Avail: NTIS HC A15/MF A01
A time dependent model of the response of the total flow to the aerodynamic solicitations at conditions favorable for the onset of stall was analyzed. Simplified special cases are discussed. Theory and experiment compare accurately in some limited cases. The main difficulties appear when the perturbations are not of a limited amplitude, when the hub-to-tip ratio of the compressor becomes small, and when compressibility effects have to be taken into account. Author (ESA)

N79-28561# Rolls-Royce Ltd., Bristol (England).
AXIAL TURBINE PERFORMANCE PREDICTION
R. J. Latimer *In* Von Karman Inst. for Fluid Dyn. Off-Design Performance of Gas Turbines, Vol. 1 1978 119 p

Avail: NTIS HC A15/MF A01
Turbine off-design behavior and performance predictions are reviewed. Actual turbine behavior is covered showing test results from which a generalized pattern results. Difficulties predicting the off-design behavior are shown by the multiplicity of methods that have been published. Design point prediction methods including possible developments are discussed in detail. The effect of design point and off-design prediction methods on design criteria is commented on. A further problem, that it will probably be necessary to consider the precise blade shape and not just its overall parameters, is also mentioned. A method of performance estimation for axial flow turbines is presented as an appendix. Author (ESA)

N79-28563# Brown, Boveri and Co., Ltd., Baden (Switzerland).
A GAS TURBINE OFF-DESIGN COMPUTING SYSTEM
Utz Klingenboeck and Axel vonRappard *In* Von Karman Inst. for Fluid Dyn. Off-Design Performance of Gas Turbines, Vol. 2 1978 94 p refs
Avail: NTIS HC A10/MF A01
A program for the design of gas turbine plants is described. The program was written for an IBM 370/618 computer using FORTRAN 4 language, 450 KB program length, punched cards input, and print-out output. Program requirements and basic concepts are explained. The calculation method is discussed in detail. Input and output specifications are considered. Aerodynamic characteristics taken into consideration by the computer procedure are discussed. An example is presented. Author (ESA)

N79-28564# Gutehoffnungshuette Sterkrade A.G. (West Germany).
CONTRIBUTION TO THE CALCULATION OF THE DYNAMIC BEHAVIOR OF INDUSTRIAL TURBOCOMPRESSOR CIRCUITS
Heinrich Voss *In* Von Karman Inst. for Fluid Dyn. Off-Design Performance of Gas Turbines, Vol. 2 1978 34 p refs

Avail: NTIS HC A10/MF A01
A calculation method was developed which can predict the required turbocompressor circuits performance from data on the various individual components. The method is based on a components indexing system which, after numeric editing of the plant to be investigated, forms a circuit matrix. The program contains a set of indexed components which are treated by a processing computer using digital programming techniques. Initial comparison of precalculations and measurements indicate agreement. Two examples are presented. Author (ESA)

N79-28565# Ateliers de Constructions Electriques de Charleroi (Belgium).

PROBLEMS INVOLVED IN STARTING AND SHUTDOWN OF GAS TURBINES: THERMODYNAMIC AND MECHANICAL ASPECTS
J.-L. Guiette and Albert VanGucht *In* Von Karman Inst. for Fluid Dyn. Off-Design Performance of Gas Turbines, Vol. 2 1978 95 p refs
Avail: NTIS HC A10/MF A01

A calculation method for the transient performances of the turbine and compressor is given and the assumptions are pointed out. Although simplifications are introduced, the work involved in determining start up and shutdown characteristics is considerable. Differences occur between measured and calculated data, but they can be explained by the simplifications made. The accuracy of the calculation method is considered satisfactory. Author (ESA)

N79-28567# National Engineering Lab., East Kilbride (Scotland). Fluid Mechanics Div.
PUMP DESIGN
I. S. Pearsall *In* Von Karman Inst. for Fluid Dyn. Off-Design Performance of Pumps, Vol. 1 1978 14 p

Avail: NTIS HC A22/MF A01

The isolated airfoil method with corrections for blade interference, the cascade method, and the actuator disks method are reviewed. Formulas are developed and limitations and restrictions are explained. Author (ESA)

N79-28568# National Engineering Lab., East Kilbride (Scotland).
A COMPUTER-AIDED DESIGN METHOD FOR AXIAL FLOW PUMPS AND FANS
J. E. Hesselgreaves and O. McEwan *In* Von Karman Inst. for Fluid Dyn. Off-Design Performance of Pumps, Vol. 1 1978 40 p refs
Avail: NTIS HC A22/MF A01

Programs for the design of axial flow pumps and fans with or without stator rows are described. Controlled variation of spanwise loading is incorporated into the method which is valuable where special design requirements are to be met. The methods of analysis are described together with the organization of the programs. Some numerical results are given together with supporting experimental evidence. Author (ESA)

N79-28574# Worthington Pump International, Inc., Desio (Italy).
PREROTATION IN CENTRIFUGAL PUMPS: DESIGN CRITERIA
A. Janigro and B. Schiavello *In* Von Karman Inst. for Fluid Dyn. Off-Design Performance of Pumps, Vol. 1, 1978 100 p refs
Avail: NTIS HC A22/MF A01

After a survey of the literature complemented by flow visualization and flow measurement tests, a qualitative scheme was conceived for the interpretation of the main phenomena related to separation, backflow, and prerotation in centrifugal pumps. An identical sequence, separation-backflow-rotation, develops at part capacities in centrifugal, mixed, and axial rotors. Onset of these phenomena is discussed and related to pump design as well as operation characteristics. Author (ESA)

N79-28614*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
A METHOD FOR OBTAINING PRACTICAL FLUTTER-SUPPRESSION CONTROL LAWS USING RESULTS OF OPTIMAL CONTROL THEORY
Jerry R. Newson Aug. 1979 34 p refs
(NASA-TP-1471; L-12728) Avail: NTIS HC A03/MF A01 CSCL 20K

The results of optimal control theory are used to synthesize a feedback filter. The feedback filter is used to force the output of the filtered frequency response to match that of a desired optimal frequency response over a finite frequency range. This matching is accomplished by employing a nonlinear programing algorithm to search for the coefficients of the feedback filter that minimize the error between the optimal frequency response and the filtered frequency response. The method is applied to the synthesis of an active flutter-suppression control law for an aeroelastic wind-tunnel model. It is shown that the resulting control law suppresses flutter over a wide range of subsonic Mach numbers. This is a promising method for synthesizing practical control laws using the results of optimal control theory. A.R.H.

N79-28620# Lockheed-Georgia Co., Marietta.
INVESTIGATION OF STRESS-STRAIN HISTORY MODELING AT STRESS RISERS, PHASE 2 Final Report, 15 Feb. 1977 - 30 Sep. 1978
James R. Carroll, R. L. Brugh, and W. Wilkinson Dec. 1978 261 p refs
(Contract F33615-75-C-3078)
(AD-A069162; LG78ER240; AFFDL-TR-78-167) Avail: NTIS HC A12/MF A01 CSCL 01/3

An analytical and experimental study of the stress and strain history at stress risers was conducted to evaluate the effects of time- and cycle-dependent changes on the fatigue life of aluminum alloy structures. This report covers Phase II of a two-phase program. Both creep and stress relaxation were modeled and measured. An elastic-plastic finite element code simulation was utilized to model the nonlinear stress-strain field around the stress riser and to model creep sustained load hold periods. A four-part experimental program was conducted to generate constitutive data necessary for the formulation of a hysteresis analysis model. The experimental program included simple coupon specimens, a unique simplified stress concentration specimen, center circularly notched super-scale specimens, and notched fatigue specimens. Significant creep and stress relaxation was measured during the experimental program. These data were used in the development of a creep/stress relaxation module for the hysteresis analysis. The automated hysteresis analysis developed during this program includes a material hardening/softening module, a creep/stress relaxation module, locus and branch curve definition for the stable material response, and a damage accumulation module. Correlation studies have been conducted using this analysis as well as a linear damage analysis method to compare predicted versus actual specimen life. GRA

N79-28796*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va
EFFECTS OF ROAD TRAFFIC BACKGROUND NOISE ON JUDGMENTS OF INDIVIDUAL AIRPLANE NOISES Ph.D. Thesis
Clemans A. Powell Jul. 1979 44 p refs
(NASA-TP-1433; L-12651) Avail: NTIS HC A03/MF A01 CSCL 13B

Two laboratory experiments were conducted to investigate the effects of road-traffic background noise on judgments of individual airplane flyover noises. In the first experiment, 27 subjects judged a set of 16 airplane flyover noises in the presence of traffic-noise sessions of 30-min duration consisting of the combinations of 3 traffic-noise types and 3 noise levels. In the second experiment, 24 subjects judged the same airplane flyover noises in the presence of traffic-noise sessions of 10-min duration consisting of the combinations of 2 traffic-noise types and 4 noise levels. In both experiments the airplane noises were judged less annoying in the presence of high traffic-noise levels than in the presence of low traffic-noise levels. Author

N79-28848# National Aviation Facilities Experimental Center, Atlantic City, N. J.
THE ANALYSIS OF NATIONAL TRANSPORTATION SAFETY BOARD SMALL SINGLE-ENGINE FIXED-WING AIRCRAFT ACCIDENT/INCIDENT REPORTS FOR THE POTENTIAL PRESENCE OF LOW-LEVEL WIND SHEAR Final Report
Jack J. Shrager May 1979 78 p refs
(AD-A069438; FAA-RD-79-3; FAA-NA-78-39) Avail: NTIS HC A05/MF A01 CSCL 04/2

The National Transportation Safety Board aircraft accident/incident data base covering the years 1964 through 1975 was screened to select those accidents involving single-engine aircraft of less than 12,500 pounds gross weight in which the potential of low-level wind shear as a factor could not be discounted.

The software filtering resulted in identifying 2,469 small single-engine aircraft accident briefs which met the criteria for the possible presence of wind shear. A review of these briefs for the years 1964 through 1973 (excluding 1970, 1971, 1974, and 1975) further reduced this number to 304, which comprised the final data base used in this analysis. The presence of a low-level wind shear was a distinct possibility in 71 of these takeoff, approach, or landing accidents. Of this number, 48 involved mechanically (orographic or topographic) induced shears. In 23 of the cases, thunderstorms were reported or observed close to the aircraft flightpath. Author

N79-28982*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

JET NOISE AND PERFORMANCE COMPARISON STUDY OF A MACH 2.55 SUPERSONIC CRUISE AIRCRAFT

V. R. Mascitti and D. J. Maglieri Jun. 1979 24 p refs

(NASA-TM-80094) Avail: NTIS HC A02/MF A01 CSCL 20A

Data provided by the manufacturer relating to noise and performance of a Mach 2.55 supersonic cruise concept employing a post 1985 technology level, variable cycle engine was used to identify differences in noise levels and performance between the manfacturer and NASA associated with methodology and groundrules. In addition, economic and noise information is provided consistent with a previous study based on an advanced technology Mach 2.7 configuration. The results indicate that the difference between the NASA's and manfacturer's performance methodology is small. Resizing the aircraft to NASA groundrules also results in small changes in flyover, sideline and approach noise levels. For the power setting chosen, engine oversizing resulted in no reduction in traded noise. In terms of summated noise level, a 10 EPNdB reduction is realized for an 8 percent increase in total operating costs. This corresponds to an average noise reduction of 3.3 EPNdB at the three observer positions. A.R.H.

N79-28984*# Massachusetts Inst. of Tech., Cambridge. Fluid Dynamics Research Lab.

EXPERIMENTAL AND THEORETICAL STUDIES ON MODEL HELICOPTER ROTOR NOISE Interim Report, Mar. 1976 - Dec. 1977

Krishnaswamy S. Aravamudan and Wesley L. Harris Jan. 1978 158 p refs Submitted for publication

(Grant NsG-2095; Contract DAAG29-76-C-0027)

(NASA-CR-158844; AD-A068180; ARO-12931.2-EX; Rept-83852-1; Rept-78-1) Avail: NTIS HC A08/MF A01 CSCL 20/1

A simplified Mach number scaling law is obtained for rotational and broadband noise components of a model helicopter rotor. The broadband noise sources are further classified into low frequency and high frequency components. The scaling laws are based on the geometric and performance parameters of the rotor and characteristics of the flow field. The existing theory of Lowson and Ollerhead is used deriving the conventional sixth power law for the rotational noise of geometrically similar blades operating in similar flow environments. The knowledge of unsteady aerodynamics was exploited to yield analytical formulation for the low frequency broadband radiation. The ambiguous state of the art regarding the origin and nature of high frequency broadband noise does not permit such a straightforward scaling law for this frequency regime. Vortices are assumed to be shed at unknown Strouhal frequency and the scaling law is derived by simply integrating the blade sectional velocity over the span. The MIT 5 x 7-1/2 foot anechoic wind tunnel was used to perform experiments at controlled flow environ. Turbulence was generated at the inlet of the tunnel and simultaneous measurements of acoustic and turbulence signals were made. The experimentally obtained results are compared with the computed intensities and spectra of rotational noise, low frequency broadband noise and high frequency broadband noise from model rotors. GRA

N79-29105# Committee on Science and Technology (U. S. House).

NASA AUTHORIZATION, 1980, VOLUME 1, PART 2

Washington GPO 1979 427 p refs Hearing on H.R. 1786 before the Comm. on Sci. and Technol., 96th Congr., 1st Sess., 6 Feb. 1979

(GPO-46-134) Avail: Comm. on Sci. and Technol.

The President's budget for NASA is reviewed in the light of his civilian space policy and its impact on NASA programs. Major activities of FY 1980 highlighted include the space transportation system, space sciences, space and terrestrial applications, aeronautics and space technology, space tracking and data systems, construction of facilities, research and program management, and international programs. The budget request is considered to comprise a sound, balanced aeronautics and space program, given the constraints of the national anti-inflational effort. It supports the continued development of the space transportation system, meets commitments made in the past, maintains progress in ongoing programs, and provides for flexibility in future programs. A.R.H.

N79-29108*# National Aeronautics and Space Administration, Washington, D. C.

SPINOFF 1979 Annual Report

James J. Haggerty Feb. 1979 118 p Original contains color illustrations

(NASA-TM-80481) Avail: NTIS MF A01; SOD HC $4.25 CSCL 05A

NASA's current mainline programs which are producing public benefit through direct application of technology and, at the same time, are generating new technology which may find secondary application in the future are summarized. A representative sampling of spinoff products and processes derived from NASA technology and employed in various avenues of everyday life is included. The mechanisms of the technology transfer process, including the means by which NASA seeks to stimulate technology utilization are described as well as NASA's activities in assisting agencies interested in exploiting the benefit potential of satellite remote sensing technology. A.R.H.

N79-29138# Dayton Univ. Research Inst., Ohio.

PREDICTED CRACK REPAIR COSTS FOR AIRCRAFT STRUCTURES Final Technical Report, Jun. 1977 - Sep. 1978

Alan P. Berens Nov. 1978 83 p refs

(Contract F33615-77-C-0800)

(AD-A068699; ASD-TR-78-39) Avail: NTIS HC A05/MF A01 CSCL 01/3

This report presents the results of a study designed to (1) prepare a computer program for use in predicting expected repair costs of the cracks which develop during the operational usage of a structure; (2) to provide a document which describes the use of the computer program and guides a potential user in the specification of the required input; and (3) to use data which is reasonably representative of Air Force experience as input for use in determining the sensitivity of expected maintenance costs to variations in input. Results are provided which compare expected costs for changes in inspection intervals, quality of inspection, quality of repair, operational usage, and equivalent initial flaw size distributions. GRA

N79-29141*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

A COMPUTER PROGRAM FOR DETAILED ANALYSIS OF THE TAKEOFF AND APPROACH PERFORMANCE CAPABILITIES OF TRANSPORT CATEGORY AIRCRAFT

Willard E. Foss, Jr. Jun. 1979 38 p refs

(NASA-TM-80120) Avail: NTIS HC A03/MF A01 CSCL 01A

The takeoff and approarch performance of an aircraft is calculated in accordance with the airworthiness standards of the Federal Aviation Regulations. The aircraft and flight constraints are represented in sufficient detail to permit realistic sensitivity studies in terms of either configuration modifications or changes in operational procedures. The program may be used to investigate advanced operational procedures for noise alleviation such as programmed throttle and flap controls. Extensive profile time history data is generated and is placed on an interface file which can be input directly to the NASA aircraft noise prediction program (ANOPP). A.R.H.

N79-29143*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
RECENT APPLICATIONS OF THEORETICAL ANALYSIS TO V/STOL INLET DESIGN
Norbert O. Stockman 1979 18 p refs Presented at Workshop on V/STOL Aerodyn., Monterey, Calif. 16-18 May 1979; sponsored by Naval Air Develop. Center
(NASA-TM-79211; E-096) Avail: NTIS HC A02/MF A01 CSCL 01A

The theoretical analysis methods, potential flow, and boundary layer, used at Lewis are described. Recent application to Navy V/STOL aircraft, both fixed and tilt nacelle configurations, are presented. A three dimensional inlet analysis computer program is described and preliminary results presented. An approach to optimum design of inlets for high angle of attack operations is dicussed. M.M.M.

N79-29144*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
AERODYNAMIC CHARACTERISTICS OF A LARGE-SCALE SEMISPAN MODEL WITH A SWEPT WING AND AN AUGMENTED JET FLAP WITH HYPERMIXING NOZZLES
Thomas N. Aiken, Michael D. Falarski, and David G. Koenin Jul. 1979 87 p refs
(NASA-TM-73236; A-7013) Avail: NTIS HC A05/MF A01 CSCL 01A

The aerodynamic characteristics of the augmentor wing concept with hypermixing primary nozzles were investigated. A large-scale semispan model in the Ames 40- by 80-Foot Wind Tunnel and Static Test Facility was used. The trailing edge, augmentor flap system occupied 65% of the span and consisted of two fixed pivot flaps. The nozzle system consisted of hypermixing, lobe primary nozzles, and BLC slot nozzles at the forward inlet, both sides and ends of the throat, and at the aft flap. The entire wing leading edge was fitted with a 10% chord slat and a blowing slot. Outboard of the flap was a blown aileron. The model was tested statically and at forward speed. Primary parameters and their ranges included angle of attack from -12 to 32 degrees, flap angles of 20, 30, 45, 60 and 70 degrees, and deflection and diffuser area ratios from 1.16 to 2.22. Thrust coefficients ranged from 0 to 2.73, while nozzle pressure ratios varied from 1.0 to 2.34. Reynolds number per foot varied from 0 to 1.4 million. Analysis of the data indicated a maximum static, gross augmentation of 1.53 at a flap angle of 45 degrees. Analysis also indicated that the configuration was an efficient powered lift device and that the net thrust was comparable with augmentor wings of similar static performance. Performance at forward speed was best at a diffuser area ratio of 1.37. K.L.

N79-29146*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
AN EXPERIMENTAL AND THEORETICAL INVESTIGATION OF THE EFFECT OF NONMETRIC OVER-THE-WING NACELLES ON WING-BODY AERODYNAMICS
David E. Reubush Aug. 1979 79 p refs
(NASA-TP-1503; L-13010) Avail: NTIS HC A05/MF A01 CSCL 01A

Drag reduction benefits due to blowing the jet exhausts over the wing for a transport-type wing-body configuration were investigated in the Langley 16-foot transonic tunnel. A combination of a wing-body model and a powered-nacelle test rig was tested at Mach numbers of 0.50 and 0.80 at angles of attack from -2 degrees to 4 degrees and jet total-pressure ratios from jet off to 3 or 4 (depending on Mach number) for a variety of nacelle locations relative to the wing. The experimental results were compared with the predictions obtained from several theoretical techniques. It was concluded that positioning of the nacelles (nonmetric) can have large effects on the wing-body drag. Some positions yielded higher drag than the baseline position, whereas others yielded lower drag than the baseline position. The theoretical method which utilized a quasi-vortex-lattice for the wing and wing-jet interaction in combination with a jet entrainment model gave generally reasonable predictions of the drag increments. M.M.M.

N79-29149# ARO, Inc., Arnold Air Force Station, Tenn.
WING/STORE FLOW-FIELD MEASUREMENTS AT TRANSONIC SPEEDS USING A LASER VELOCIMETER Final Report, 18 Apr. 1977 - 30 Sep. 1978
F. L. Heltsley and V. A. Cline AEDC Apr. 1979 62 p refs
(AD-A068328; AEDC-TR-79-5) Avail: NTIS HC A04/MF A01 CSCL 01/3

A test was conducted in the AEDC Aerodynamic Wind Tunnel (1T) of the Propulsion Wind Tunnel Facility (PWT) to measure the flow fields about 5-percent models of several wing/store configurations. Test models included a wall-mounted swept wing and MK-83 and M-117 stores. Flow-field velocity measurements, made using a 2-component laser velocimeter, are presented together with model surface pressures and shadowgraphs. GRA

N79-29150# Goodyear Aerospace Corp., Akron, Ohio.
GOODYEAR AEROSPACE CONCEPTUAL DESIGN MARITIME PATROL AIRSHIP ZP3G Final Report
N. D. Brown 1 Apr. 1979 65 p refs
(Contract N62269-78-M-4580)
(AD-A068449; GER-16607; NADC-780-75-60) Avail: NTIS HC A04/MF A01 CSCL 01/3

A conceptual design of a modern technology airship with precision hover capability for use in maritime patrol is described. The size and major characteristics are established by a series of United States Coast Guard missions set forth by the contracting agency. GRA

N79-29152# Sandia Labs., Albuquerque, N. Mex.
REAL-TIME ESTIMATION OF AERODYNAMIC COEFFICIENTS BY MEANS OF AN EXTENDED KALMAN FILTER
J. R. Kelsey Feb. 1979 156 p refs
(Contract EY-76-C-04-0789)
(SAND-78-2032) Avail: NTIS HC A08/MF A01

A technique for estimation of the aerodynamic parameters of a flight vehicle from onboard measurements is presented. An extended Kalman filter is used to extract the parameters in the presence of measurement noise and initial uncertainty of the parameter values. Computer generated data were used for the measurement information in lieu of actual flight data. Several state models of varying complexity were studied in an attempt to find a model which yields adequate estimates while minimizing the required computation time. DOE

N79-29154# Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.
AN EXTENSION TO THE METHOD OF GARABEDIAN AND KORN FOR THE CALCULATION OF TRANSONIC FLOW PAST AN AEROFOIL TO INCLUDE THE EFFECTS OF A BOUNDARY LAYER AND WAKE
M. R. Collyer Jul. 1978 93 p refs Previously announced as RAE-TR-77104; ARC-37680
(ARC-R/M-3828; BR66513) Avail: NTIS HC A05/MF A01; HMSO £8

A numerical method was developed for calculating compressible (including transonic) flow past a single airfoil with an allowance for viscous effects, providing that the boundary layer is fully attached over the airfoil surface. This method was developed by combining an iterative scheme for the inviscid flow, originally established by Garabedian and Korn, with an integral method (the lag entrainment method of Green et al) for the calculation of compressible turbulent boundary layers. The inviscid scheme was modified to incorporate a boundary condition on the airfoil surface, which is imposed on the velocity normal to the surface, with a corresponding boundary condition for the wake. Wake curvature effects are also included. An iterative procedure is established, which iterates between successive calculations of the pressure distribution and of the displacement thickness of the boundary layer and wake. Results are presented from a computer program (VGK) and comparisons are made with experimental measurements and other theoretical results. Author (ESA)

N79-29155# Cambridge Univ. (England). Dept. of Engineering.
THE AERODYNAMIC NOISE OF A SLOT IN AN AEROFOIL

M. S. Howe Aug. 1977 45 p refs Previously announced as RAE-TR-77129; ARC-37794
(ARC-R/M-3830; BR66512) Avail: NTIS HC A03/MF A01
A theoretical investigation of the noise generated when turbulence interacts with a slot between a wing and a flap is described. The slot is modeled by the region between two overlapping, semi-infinite rigid planes representing the wing and flap. Sound is produced when turbulence convects above, below or through the slot. The analysis determines the dependances of the radiated sound on the characteristics turbulence velocity, the effect of forward flight on the field shape, and properties of the field radiated to the side of the aircraft flight path. Results indicate that above-the-wing-turbulence generates a monopole field in the flyover plane which is amplified in forward flight. For acoustic frequencies less than half that of the lowest resonant frequency of the slot the radiation is that of a monopole source whose intensity varies. Sideline noise exhibits dipole characteristics except at frequencies less than half the lowest resonance frequency of the slot, or at high sideline angles. Author (ESA)

N79-29156# Aerospace Engineering Test Establishment, Cold Lake (Alberta).
CH-113 CRASH POSITION INDICATOR FLIGHT TRIALS
K. D. Nelson 5 Mar. 1979 35 p refs Original contains color illustrations
(AETE-78/39) Avail: NTIS HC A03/MF A01
Tests were performed on the crash position indicator (CPI) installed on a CF CH-113 Labrador aircraft to determine the safe deployment envelope and the effect of CPI fitment on the flying qualities of the CH-113. The tuft predictions of CPI airfoil separation and trajectory were validated. Author

N79-29157# National Transportation Safety Board, Washington, D. C.
AIRCRAFT ACCIDENT REPORT: ROCKY MOUNTAIN AIRWAYS, INC., DEHAVILLAND DHC-6-300, N24RM, CHEYENNE, WYOMING, 27 FEBRUARY 1979
19 Jul. 1979 30 p
(NTSB-AAR-79-10) Avail: NTIS HC A03/MF A01
About 0807 mountain standard time, Rocky Mountain Airways, Inc., Flight 801, crashed into rolling terrain shortly after takeoff in visual flight conditions from runway 34 at Cheyenne Municipal Airport, Wyoming. The aircraft came to rest about 1.3 nmi east of the departure end of the runway. There were 14 passengers and a crew of 2 aboard; 2 passengers were injured slightly. The aircraft was damaged substantially. The National Transportation Safety Board determined that the probable cause of the accident was the flightcrew's erroneous determination that the aircraft was not capable of single-engine flight and their actions which precluded obtaining maximum available performance from the aircraft. The cause of the engine failure was an erroneous assessment by company maintenance personnel of damage sustained by the right engine during an overtemperature condition and their poor judgment in deciding to repair and release the engine for flight without replacing the engine's power turbine section. Author

N79-29158# National Transportation Safety Board, Washington, D. C.
AIRCRAFT ACCIDENT REPORT: CONTINENTAL AIR LINES, INC., BOEING 727-224, N32725, TUCSON, ARIZONA, 3 JUNE 1977
1 Aug. 1978 43 p refs
(NTSB-AAR-78-9) Avail: NTIS HC A03/MF A01
The aircraft was damaged substantially after striking the powerlines and utility poles, which were located about 130 feet to the left of the runway centerline and about 710 feet from the departure end of the runway. The aircraft was landed safely at the Tucson Airport; there were no injuries. The National Transportation Safety Board determines that the probable cause of the accident was the captain's decision to take off under evident hazardous wind conditions which resulted in an encounter with severe wind shear and subsequent collision with obstacles in the takeoff path. The rate of climb of the aircraft in these conditions when flown according to prescribed operating procedures was not sufficient to clear the obstacles. If the aircraft's full aerodynamic capability was used, collision with obstacles probably could have been avoided. S.E.S.

N79-29159# National Transportation Safety Board, Washington, D. C.
AIRCRAFT ACCIDENT REPORT: UNITED AIRLINES, INC., DOUGLAS DC-8-54, N8047U NEAR KAYSVILLE, UTAH, 18 DECEMBER 1977
27 Jul. 1978 48 p
(NTSB-AAR-78-8) Avail: NTIS HC A03/MF A01
About 0138 m.s.t. on December 18, 1977, a United Airlines, Inc., DC-8F-54 cargo aircraft, operating as Flight 2860, crashed into a mountain in the Wasatch Range near Kaysville, Utah. The three flightcrew members, the only persons aboard the aircraft, were killed, and the aircraft was destroyed. Flight 2860 encountered electrical system problems during its descent and approach to the Salt Lake City Airport. The flight requested a holding clearance which was given by the approach controller and accepted by the flightcrew. The flight then requested and received clearance to leave the approach control frequency for a little minute to communicate with company maintenance. Flight 2860 was absent from the approach control frequency for about 7 1/2 minutes. During that time, the flight entered an area near hazardous terrain. The approach controller recognized Flight 2860's predicament but was unable to contact the flight. When Flight 2860 returned to approach control frequency, the controller told the flight that it was too close to terrain on its right and to make a left turn. After the controller repeated the instructions, the flight began a left turn and about 15 seconds later the controller told the flight to climb immediately to 8,000 feet. Eleven seconds later, the flight reported that it was climbing from 6,000 feet to 8,000 feet. The flight crashed into a 7,665-foot mountain near the 7,200-foot level. The National Transportation Safety Board determines that the probable cause of this accident was the approach controller's issuance and the flightcrew's acceptance of an incomplete and ambiguous holding clearance in combination with the flightcrew's failure to adhere to prescribed impairment-of-communications procedures and prescribed holding procedures. The controller's and flightcrew's actions are attributed to probable habits of imprecise communication and of imprecise adherence to precedures developed through years of exposure to operations in a radar environment. Contributing to the accident was the failure of the aircraft's No. 1 electrical system for unknown reasons. Author

N79-29160# National Transportation Safety Board, Washington, D. C.
AIRCRAFT ACCIDENT REPORT: ALASKA AERONAUTICAL INDUSTRIES, INC., DEHAVILLAND DHC-6-200, N563MA, NEAR ILIAMNA, ALASKA, 6 SEPTEMBER 1977
4 May 1978 31 p
(NTSB-78-5) Avail: NTIS HC A03/MF A01
On September 6, 1977, Alaska Aeronautical Industries, Inc. Flight 302 crashed into a glacier on the southwest side of Mt. Iliamna, Alaska, about 7,000 feet above mean sea level. The aircraft crashed in level flight in instrument meteorological conditions while en rouge from Iliamna, Alaska, to Anchorage, Alaska. There were two crewmenbers and eleven passengers aboard the aircraft; there were no survivors. The aircraft was destroyed. Because of the rapidly changing environmental conditions on the glacier face, recovery of bodies or wreckage was not possible. The National Transportation Safety Board has determined that the probable cause of the accident was the failure of the flightcrew to use proper navigational procedures for the route to be flown, especially their failure to use the available backup means of navigation to verify the position and the progress of the flight. Author

N79-29161# National Transportation Safety Board, Washington, D. C.
AIRCRAFT ACCIDENT REPORT: NATIONAL JET SERVICES, INC., DOUGLAS DC-3, N51071, EVANSVILLE DRESS REGIONAL AIRPORT, INDIANA, 13 DECEMBER 1977
17 Aug. 1978 52 p refs
(NTSB-AAR-78-10) Avail: NTIS HC A04/MF A01
Results of an aircraft accident investigation of a Douglas DC-3, operated as a passenger charter flight to transport the

University of Evansville basketball team and associated personnel from Evansville, Indiana, to Nashville, Tennessee are reported. The probable cause of the accident was an attempted takeoff with the rudder and right aileron control locks installed, in combination with a rearward center of gravity, which resulted in the aircraft's rotating to a nose-high attitude immediately after takeoff and entering the region of reversed command from which the pilot was unable to recover. Contributing to the accident was the failure of the flight crew to insure that the passenger baggage was loaded in accordance with the configuration contained on the load manifest. Their failure resulted in a rearward center of gravity that was aft of the optimum range, but forward of the rearmost limit. A.W.H.

N79-29162# Committee on Commerce, Science, and Transportation (U. S. Senate).
AVIATION SAFETY
Washington GPO 1978 163 p refs Joint hearing before the Comm. on Commerce, Sci., and Transportation and the Comm. on Public Works and Transportation, 95th Congr., 2d Sess., 27 Oct. 1978
(GPO-37-810) Avail: Comm. on Commerce, Sci. and Transportation

Midair collisions and the systems improvements which will reduce the potential of these accidents are examined. Changes in procedures and standards that can help prevent a potential accident are emphasized. Specifically, the topics addressed are: (1) the air traffic control procedures after a conflict alert; (2) the requirement for positive control at more major air carrier airports; (3) the development and installation of both ground-based and airborne collision avoidance systems and what can be done to accelerate the introduction of that safety hardware; and (4) the issue of accelerating the implementation of reliever airports to provide incentives for reducing the mix of general aviation and air carriers at major airports. J.M.S.

N79-29163# Payne, Inc., Annapolis, Md.
WIND TUNNEL TEST OF ACES 2 EJECTION SEAT WITH ANTHROPOMETRIC DUMMY IN ASYMMETRIC CONFIGURATIONS Final Report, 15 Sep. 1976 - 30 Sep. 1978
Fred W. Hawker and Peter R. Payne Wright-Patterson AFB, Ohio AMRL Jan. 1979 53 p refs
(Contract F33615-76-C-0530; AF Proj. 7231)
(AD-A068614; Working-Paper-210-2; AMRL-TR-78-108) Avail: NTIS HC A04/MF A01 CSCL 01/2

Previous investigations have determined the aerodynamic forces and moments acting upon an open ejection seat and its occupant when the seat occupant was sitting symmetrically with respect to the seat axes, with his limbs in the correct 'stowed' positions. The present investigation was undertaken to determine the changes in the aerodynamic forces due to deviations from this ideal position; principally off-center asymmetry and changes to limb movement. GRA

N79-29164# Stanford Telecommunications, Inc., McLean, Va.
INVESTIGATION OF A PRELIMINARY GPS RECEIVER DESIGN FOR GENERAL AVIATION Final Report
B. D. Elrod and F. D. Natali Los Angeles AFS SAMSO 14 Jul. 1978 132 p refs
(Contracts F04701-75-C-0239; DOT-FA77WAI-37)
(AD-A069059; STI/E-TR-8022; SAMSO-TR-79-34) Avail: NTIS HC A07/MF A01 CSCL 17/7

The preliminary design and analysis of a potentially low cost GPS receiver for general aviation navigation applications is presented. The results indicate that the receiver could meet or exceed 2D area navigation (RNAV) requirements without dependence on external altitude data. GRA

N79-29170# Aerospace Engineering Test Establishment, Cold Lake (Alberta).
CH-147 EMC EVALUATION OF SELECTED SUBSYSTEMS, EMC TEST REPORT
R. A. Lagrange 17 May 1979 16 p refs
(AETE-77/16-4) Avail: NTIS HC A02/MF A01

An electromagnetic interference/compatibility investigation was performed on the CH 147005 Chinook helicopter fitted with a high intensity anti-collision strobe light, a crash position indicator, and Omega Navigation system in order to (1) identify the cause of EMI problems detected during category 1 tests; (2) determine the EMC of the three newly installed avionics systems: and (3) develop and evaluate possible corrective action for eliminating or reducing EMI/C problems. The methods used and results obtained are described. A.R.H.

N79-29171*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
FRICTION AND WEAR CHARACTERISTICS OF WIRE-BRUSH SKIDS
Robert C. Dreher Aug. 1979 30 p refs
(NASA-TP-1495; L-13095) Avail: NTIS HC A03/MF A01 CSCL 01C

The testing technique consisted of towing the skids with a ground test vehicle over asphalt and concrete surfaces at ground speeds up to 80 km/hr (50 mph) and bearing pressures up to 689 kPa (100 psi) over sliding distances up to 1585 m (5200 ft). Results indicate that the friction coefficient developed by wire brush skids is essentially independent of ground speed, is slightly increased with increasing bearing pressure, is noticeably affected by surface texture, and is not degraded by surface wetness. Skid wear is shown to increase with increasing bearing pressure and with increasing ground speed and is dependent on the nature of the surface. Runway surface damage caused by the skids was in the form of an abrasive scrubbing action rather than physical damage. S.E.S.

N79-29173# Rockwell International Corp., El Segundo, Calif.
AIRCRAFT TRANSPARENCY FAILURE AND LOGISTICAL COST ANALYSIS. VOLUME 2: DESIGN DATA AND MAINTENANCE PROCEDURES Final Report, Jun. 1977 - Sep. 1978
S. S. Brown Dec. 1978 151 p refs
(Contract F33615-77-C-3060; AF Proj. 2402)
(AD-A068720; NA-78-604-Vol-2; AFFDL-TR-78-153-Vol-2) Avail: NTIS HC A08/MF A01 CSCL 01/3

The aircraft transparency and logistical cost analysis program is aimed at reducing the logistical costs associated with transparency systems for 20 of the current Air Force inventory aircraft. The approach for achieving this goal was to collect all information relating to the physical and performance characteristics, and maintenance historical data of the selected study aircraft. These data provide the means of initiating search for design improvement and cost reduction studies. In order to assess the maintenance and logistical support activity as currently being practical at the Air Logistics Centers and Air Force Operational Bases, both maintenance and installation procedures, as well as qualification and testing procedures, for transparency components and support systems were collected. These data were assembled to determine the support structure level of effort and costs to identify those procedures and practices where cost reduction may be achieved. These data plus the failure analysis conducted in the transparency analysis phases provided the basis for implementing the design improvement and cost reduction studies shown in volume 3. GRA

N79-29174# Rockwell International Corp., El Segundo, Calif.
AIRCRAFT TRANSPARENCY FAILURE AND LOGISTICAL COST ANALYSIS. VOLUME 3: TRANSPARENCY ANALYSIS Final Report, Jun. 1977 - Sep. 1978
S. S. Brown Dec. 1978 215 p refs
(Contract F33615-77-C-3060; AF Proj. 2402)
(AD-A068721; NA-78-604-Vol-3; AFFDL-TR-78-153-Vol-3) Avail: NTIS HC A10/MF A01 CSCL 01/3

The Rockwell Maintenance Analysis Model (MAM) program was used to extract cost data from the K051 LSC system, and maintenance failure modes from the AFM 66-1 maintenance data collection system in order to conduct a detailed logistical cost and failure analysis. The cost and maintenance frequencies were utilized to pinpoint the most productive areas for life cycle cost reduction. A number of potential improvement studies were identified in the initial phase of this program. However, the effort required to research, analyze, and assemble these data, limited the development to five design improvement studies. These factors, coupled with the relative importance of the aircraft in the Air Force inventory, initiated the search for concepts that would cure or substantially reduce the failures identified in the above noted MAM's process. The verification of the feasibility of the proposed changes was accomplished by trading the projected 10-year life cycle cost of the existing concept to the costs of the development, refurbishing, and the reduced maintenance for the revised concept. The five design improvement trade studies resulted in significantly reduced logistical support costs. GRA

N79-29176# Naval Postgraduate School, Monterey, Calif.
AN ANALYSIS OF BOLTER-HOLE SPACING IN AIRCRAFT CARRIER LANDINGS
Kneale T. Marshall May 1978 54 p ref
(AD-A068585; NPS55-78-013) Avail: NTIS HC A04/MF A01 CSCL 01/2

This paper presents an analysis of aircraft landing strategies on aircraft carriers. Optimal bolter-hole spacings are determined for various measures of effectiveness, and a short discussion is included on the use of automatic landing systems. GRA

N79-29177# Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.
THE EFFECT OF WINGLETS ON THE KC-135A AIRCRAFT Final Report, Jun. 1975 - Oct. 1977
George W. Loptien Nov. 1978 118 p refs
(AF Proj. 2404)
(AD-A068324; AFFDL-TR-78-124) Avail: NTIS HC A06/MF A01 CSCL 01/3

To investigate the effects of winglets on the aerodynamic characteristics of the KC-135 aircraft, semispan and full-span wind tunnel models with winglets have been investigated in the NASA/LRC 8-Foot Transonic Pressure Tunnel. At cruise conditions, the full-span tests indicated a total drag reduction of 5.3 percent for the model with the Boeing and NASA upper plus lower winglet configurations and 6.5 percent for the model with the NASA upper winglet configuration. A wing-tip-extension configuration tested on the semispan model had a drag reduction of about 3 percent compared to about 5 to 7 percent for the winglet configurations, however, the tip extension was not optimized for drag reduction. At cruise conditions, the wing tip extension produced the greatest increase in wing root bending moment and the upper winglets the least. The increase in wing root bending moment at cruise conditions varied from about 2.5 percent with the Boeing winglets, to about 3.5 percent with the tip extension. At cruise flight conditions, winglets on the KC-135A aircraft were estimated to reduce the drag about 8.2 percent and increase the maximum lift-drag ratio about 9.5 percent. GRA

N79-29178# Army Aviation Engineering Flight Activity, Edwards AFB, Calif.
PRELIMINARY AIRWORTHINESS EVALUATION RU-21 H GUARDRAIL V AIRCRAFT Final Report
John R. Niemann, Raymond B. Smith, William A. Norton, and Frederick S. Doten Mar. 1978 52 p refs
(AD-A068347; USAAEFA-77-11; USAAEFA-77-19) Avail: NTIS HC A04/MF A01 CSCL 01/3

The RU-21H (GR V) exhibited 1 deficiency and 10 shortcomings which will degrade its overall capability. The single-engine minimum-control airspeeds (V sub MC) were 5 to 10 knots greater than the data provided in the operator's manual. The incorrect V sub MC data presented in the operator's manual are a deficiency which warrants further testing and, as an interim measure, requires that a WARNING be incorporated in the operator's manual. Ten shortcomings listed in order of importance, are: (1) The dissimilar sense of operation of the attitude indicators; (2) the excessive glare in the cockpit caused by the navigation lights mounted on the upper surfaces of the external wing-tip pods; (3) the inaudibility of the stall warning horn when wearing helmet and oxygen mask; (4) the low intensity of the MASTER CAUTION and MASTER WARNING lights; (5) the inefficient arrangement of navigation and communications radios; (6) the premature activation of the artificial stall warning device; (7) the inability to shut down the engine by use of the condition lever; (8) the lightly damped, easily excited phugoid; (9) the ineffective lateral trim; and (10) the excessive force required to operate the radio/intercom switch. Within the scope of this test, the flying qualities of the RU-2H (GR V) aircraft are acceptable. GRA

N79-29179# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
A SIMULATION MODEL OF ATTACK HELICOPTER VULNERABILITY TO HOSTILE ARTILLERY FIRE M.S. Thesis
Emil H. Koenig, III Mar. 1979 82 p refs
(AD-A069753; AFIT/GST/SM/79M-4) Avail: NTIS HC A05/MF A01 CSCL 01/3

This thesis presents a methodology which simulates the activity, near the FEBA, of the Army's attack helicopter and the activity of hostile artillery in two formats: uniformly distributed area fire and precision fire against a point target as directed by a forward observer. A stochastic computer simulation was developed that varies the modeled activities from one replication to another. Current concepts of attack helicopter employment in the anti-armor role are used. Concepts of intervisibility, detectability, target location error, C-cubed time delay, and artillery round-to-round dispersion are also incorporated in the model. The model was experimented upon, using a hypothetical artillery weapon system, and the vulnerability predictions of the model are displayed and analyzed. GRA

N79-29180# Aeronautical Research Labs., Melbourne (Australia).
AN EXPERIMENTAL COMPARISON OF THE READABILITY OF TWO DIGITAL ALTIMETERS
G. R. White Dec. 1979 25 p refs
(ARL/SYS-Note-60; AR-001-325) Avail: NTIS HC A02/MF A01

Twelve male volunteer subjects with flying experience were required to read one of two digital altimeters while performing a two dimensional tracking task. It was found that the Smiths Type 3B servo altimeter was read in a significantly shorter time than was the Aero Mechanism Type 8047/20A capsule altimeter. The subjects evaluated indicate that the probability of misreading this altimeter is high. S.E.S.

N79-29181# TRW Defense and Space Systems Group, Redondo Beach, Calif.
DIGITAL AVIONICS INFORMATION SYSTEM (DAIS): DEVELOPMENT AND DEMONSTRATION Final Report, 28 Apr. 1975 - 30 Sep. 1978
R. C. Mason, T. R. Price, B. A. Rich, R. J. Slightam, J. A. Stautberg, W. P. Whalen, and C. E. Wilent Wright-Patterson AFB, Ohio AFAL Mar. 1979 169 p refs
(Contract F33615-75-C-1178; AF Proj. 2052)
(AD-A068438; AFAL-TR-79-1027) Avail: NTIS HC A08/MF A01 CSCL 09/3

The Digital Avionics Information System (DAIS) has been characterized as a system architecture which can be applied and configured for a broad class of avionic applications and missions. The DAIS concept, therefore, proposed that the processing, information transfer, and the control and display functions or core elements be common and service the avionic application functional areas on an integrated basis. These fundamental system characteristics, along with the DAIS system attributes, such as modifiability and modularity, are presented in this report. The specific system features which provide these characteristics and attributes are described. GRA

N79-29182# Dynamics Research Corp., Wilmington, Mass.
DIGITAL AVIONICS INFORMATION SYSTEM (DAIS): RELIABILITY AND MAINTAINABILITY MODEL USERS GUIDE, VOLUME 2 Final Report, May 1975 - Jul. 1977
Andrew J. Czuchry, Robert H. Kistler, John M. Glasier, and Marjorie A. Bristol Apr. 1979 139 p
(Contract F33615-75-C-5218; AF Proj. 2051)
(AD-A068826; AFHRL-TR-78-2(2)) Avail: NTIS HC A07/MF A01 CSCL 14/4

The digital avionics information system (DAIS) life cycle cost (LCC) study provides the Air Force with an enhanced inhouse capability to incorporate LCC considerations during all stages of the system acquisition process. This report documents a reliability and maintainability (R & M) model developed in the study and also serves as a users manual. The R & M model, a training model, and a cost model comprise the DAIS LCC impact model (LCCIM) designed for use in LCC analysis of avionics systems. In this context, its primary function is to manipulate input data banks to produce intermediate products, figures of merit, and outputs required by the training and cost models. When used in a stand-alone mode, the R & M model provides a means for analyzing the R M impact of changes in system design and maintenance concepts on system support requirements. GRA

N79-29185# Air Force Avionics Lab., Wright-Patterson AFB, Ohio.
DISPLAY MEASUREMENTS. MEASUREMENTS OF REFLECTANCE-TYPE DISPLAYS Final Technical Report, 1 Jan. 1977 - 30 Sep. 1978
Richard A. Spearnock Feb. 1979 29 p refs
(AD-A068602; AFAL-TR-79-1029) Avail: NTIS HC A03/MF A01 CSCL 05/8

This report applies the Equation of Spencer and Gray to specify the reflectance of reflective-type displays. This reflectance specification uses both a diffuse component function and a specular component function to completely describe any reflecting surface. The particular display chosen to illustrate the use of this method of specifying reflectance was the Hughes' Liquid Crystal Matrix Display. This display is a matrix display and produces an image by electrically controlling the reflectance of each individual cell. In the appendix, a simplified example using this method of reflectance specification to evaluate a liquid crystal display optical system is given. GRA

N79-29186# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
A METHOD FOR EVALUATING KC-135 AVIONICS CONFIGURATIONS M.S. Thesis
Joel R. Jerabek Mar. 1979 84 p refs
(AD-A069446; AFIT/GST/MA/79M-5) Avail: NTIS HC A05/MF A01 CSCL 01/3

The KC/C-135 Avionics Modernization Program is currently tasked with determining the feasibility of replacing the KC/C-135 navigator with cost effective avionics systems. The Avionics Evaluation Program (AEP) is a computer model that has been built to evaluate the mission impact caused by alternate avionics hardware configurations. Although the AEP was designed to model tactical aircraft missions, this thesis examines whether it could be applied to the strategic mission of the KC-135. Aircraft performance data, hardware reliability data, and abort logic criteria were input into the model. A baseline simulation was conducted using the current KC-135 configuration. Two additional configurations, single inertial navigation systems (INS) with a navigator and dual INS without a navigator, were selected and simulations conducted. These simulations were conducted with both peacetime and wartime mission scenarios. An analysis of the AEP output data revealed that the addition of a single INS produced a significant improvement in Navigational Accuracy and that by replacing the navigator with a second INS, navigational accuracy could be maintained without a change in the mission success rate. GRA

N79-29187# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
IMPLEMENTATION AND TESTING OF NUMERICAL ANALYSIS TECHNIQUES IN AVIONICS APPLICATIONS M.S. Thesis
Richard Arthur Adams Mar. 1979 155 p refs
(AD-A069299; AFIT/GCS/EE/79-1) Avail: NTIS HC A08/MF A01 CSCL 09/2

Errors due to finite wordlength are unavoidable when aircraft signal processing operations such as flight control, navigation, and fire control are implemented on a digital computer. To reduce these errors to tolerable levels, longer word-lengths can sometimes be employed. The effects of some of the errors, such as those due to arithmetic series truncation, machine roundoff, and quantization of system coefficients, can be lessened somewhat by appropriate numerical analysis techniques. An n-bit simulator which runs on Control Data Corporation (CDC) 6600/CYBER 74 computer systems was modified and then used to evaluate the accuracy of a flight navigation routine coded in FORTRAN. The routines were executed without the simulator to obtain results used for benchmarking. The n-bit simulator was employed to simulate the numerical characteristics of the AN/AYK-15A digital processor. Error plots were constructed which show the maximum errors occurring within small plotting intervals plotted against each individual input value. These plots were used to aid visually in analyzing the error characteristics of the avionics routine as it would be implemented on the AN/AYK-15A. A critical analysis of the error plots obtained showed that routines which are coded using single-precision floating-point arithmetic are prone to errors which exceed the error bounds specified for the routines. This occurs even though range reductions in the trigonometric function approximations are accomplished using extended precision. GRA

N79-29188* Vought Corp., Dallas, Tex.
RAMJET COST ESTIMATING HANDBOOK Technical Report, Apr. 1976 - Jun. 1977
H. T. Emmons, D. L. Norwood, J. E. Rasmusen, and H. E. Reynolds Laurel, Md. Chem. Propulsion Inform. Agency May 1978 306 p
(Contract F33615-76-C-2043; AF Proj. 3012)
(AD-A056991; AFAPL-TR-77-50-Vol-2) HC A14/MF A01 CSCL 21/5

Research conducted under Air Force Contract F33615-76-C-2043 to generate cost data and to establish a cost methodology that accurately predicts the production costs of ramjet engines is presented. The cost handbook contains a description of over one hundred and twenty-five different components which are defined as baseline components. The cost estimator selects from the handbook the appropriate components to fit his ramjet assembly, computes the cost from cost computation data sheets in the handbook, and totals all of the appropriate cost elements to arrive at the total engine cost. The methodology described in the cost handbook addresses many different ramjet types from simple podded arrangements of the liquid fuel ramjet to the more complex integral rocket/ramjet configurations including solid fuel ramjets and solid ducted rockets. It is applicable to a range of sizes from 6 in diameter to 18 in diameter and to production quantities up to 5000 engines. M.M.M.

N79-29189*# Teledyne CAE, Toledo, Ohio.
ADVANCED GENERAL AVIATION TURBINE ENGINE (GATE) STUDY Final Report
R. Smith and E. H. Benstein Jun. 1979 150 p refs
(Contract NAS3-20757)
(NASA-CR-159624; Teledyne-CAE-1600) Avail: NTIS HC A07/MF A01 CSCL 21E

The small engine technology requirements suitable for general aviation service in the 1987 to 1988 time frame were defined. The market analysis showed potential United States engines sales of 31,500 per year providing that the turbine engine sales price approaches current reciprocating engine prices. An optimum engine design was prepared for four categories of fixed wing aircraft and for rotary wing applications. A common core approach was derived from the optimum engines that maximizes engine commonality over the power spectrum with a projected price competitive with reciprocating piston engines. The advanced technology features reduced engine cost, approximately 50 percent compared with current technology. J.M.S.

N79-29190*# Notre Dame Univ., Ind. Dept. of Electrical Engineering.
ALTERNATIVES FOR JET ENGINE CONTROL Annual Report, 1 Mar. 1978 - 28 Feb. 1979
Michael K. Sain 28 Feb. 1979 212 p refs
(Grant NsG-3048)
(NASA-CR-158390) Avail: NTIS HC A10/MF A01 CSCL 21E

The research is classified in two categories: (1) the use of modern multivariable frequency domain methods for control of engine models in the neighborhood of a set-point, and (2) the use of nonlinear modelling and optimization techniques for control of engine models over a more extensive part of the flight envelope.

Progress in the first category included the extension of CARDIAD (Complex Acceptability Region for Diagonal Dominance) methods developed with the help of the grant to the case of engine models with four inputs and four outputs. A suitable bounding procedure for the dominance function was determined. Progress in the second category had its principal focus on automatic nonlinear model generation. Simulations of models produced satisfactory results where compared with the NASA DYNGEN digital engine deck. R.E.S.

N79-29191*# General Electric Co., Evendale, Ohio. Aircraft Engine Group.
NASA CF6 JET ENGINE DIAGNOSTICS PROGRAM: LONG-TERM CF6-6D LOW-PRESSURE TURBINE DETERIORATION
Jeffrey J. Smith Aug. 1979 116 p refs
(Contract NAS3-20631)
(NASA-CR-159618; R79AEG356) Avail: NTIS HC A06/MF A01 CSCL 21E

Back-to-back performance tests were run on seven airline low pressure turbine (LPT) modules and four new CF6-6D modules. Back-to-back test cell runs, in which an airline LPT module was directly compared to a new production module, were included. The resulting change, measured in fuel burn, equaled the level of LPT module deterioration. Three of the LPT modules were analytically inspected followed by a back-to-back test cell run to evaluate current refurbishment techniques. Author

N79-29193# Naval Air Test Center, Patuxent River, Md.
AIRCRAFT ENGINE DRIVEN ACCESSORY SHAFT COUPLING IMPROVEMENTS USING HIGH-STRENGTH NONMETALLIC ADAPTER/BUSHINGS Progress Report
Aleck Loker 20 Apr. 1979 47 p refs
(AD-A068637; NATC-TM-79-1-SY; PR-2) Avail: NTIS HC A03/MF A01 CSCL 21/5

Engine driven accessories, such as generators, starters, and pumps, are commonly connected to their respective power takeoff shafts by splined couplings. These shaft couplings, which allow rapid installation and removal of the accessory, are capable of high torque transmission and are considered to be self-centering. However, because of their rapid wear and failure rate, NAVAIRTESTCEN has engaged in a continuing spline coupling improvement program over the past 11 years. An outgrowth of this program has been the development of the new high-strength nonmetallic spline coupling adapter/bushing technology. Previous Technical Memoranda, TM 76-1 SY and TM 78-1 SY, condensed the results of these coupling improvement efforts into a description of two basic spline coupling designs (crowned circular toothed and flat toothed splines), explained their apparent success, and presented limited application and manufacturing information. This report presents a summary of the new coupling designs which have been evaluated or are planned for future tests. Previously unpublished test data and the latest applicable Military Standard Drawings are also contained therein. GRA

N79-29195*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
DESCRIPTION OF THE VTOL APPROACH AND LANDING TECHNOLOGY (VALT) CH-47 RESEARCH SYSTEM
James R. Kelly, Frank R. Niessen, John F. Garren, Jr., and Terence S. Abbott Aug. 1979 57 p refs
(NASA-TP-1436; L-12781) Avail: NTIS HC A04/MF A01 CSCL 01C

The Langley Research Center modified a CH-47B helicopter to provide a general-purpose variable-stability capability for the VTOL approach and landing technology (VALT) program. The functional aspects and capabilities of the overall system are described. Automatic decelerating approach data are presented to illustrate the performance of the overall system. A.R.H.

N79-29196*# Princeton Univ., N. J. Flight Research Lab.
AN IN-FLIGHT SIMULATOR INVESTIGATION OF ROLL AND YAW CONTROL POWER REQUIREMENTS FOR STOL APPROACH AND LANDING: DEVELOPMENT OF CAPABILITY AND PRELIMINARY RESULTS
D. R. Ellis and S. C. Raisinghani Apr. 1979 44 p refs
(Contract NAS2-7350)
(NASA-CR-152307; MAE-1422) Avail: NTIS HC A03/MF A01 CSCL 01C

A six-degree-of-freedom variable-response research aircraft was used to determine the minimum lateral-directional control power required for desirable and acceptable levels of handling qualities for the STOL landing approach task in a variety of simulated atmospheric disturbance conditions for a range of lateral-directional response characteristics. Topics covered include the in-flight simulator, crosswind simulation, turbulence simulation, test configrations, and evaluation procedures. Conclusions based on a limited sampling of simulated STOL transport configurations flown to touchdown out of 6 deg, 75 kt MLS approaches, usually with a sidestep maneuver are discussed. A.R.H.

N79-29197# Science Applications, Inc., La Jolla, Calif.
DEVELOPMENT OF CRITERIA FOR MONITORING OF AIRPORT GROUND POLLUTION. VOLUME 1: STUDY Final Report, Sep. 1975 - Jul. 1977
Claus B. Ludwig and J. Richard Yoder Nov. 1978 439 p refs 2 Vol.
(Contract DOT-FA76WA-3725)
(AD-A067242; SAI-77-910-LJ-Vol-1; FAA-RD-77-178-1-Vol-1) Avail: NTIS HC A19/MF A01 CSCL 01/5

Criteria are developed by which the validity of pollution predictions and measurements in the airport environs can be judged. The criteria are applied to three technologies: (1) predictive mathematical models; (2) measurements by point samplers; and (3) measurements by remote monitors. For mathematical models, the criterion is the agreement between predicted and measured pollution levels. Various mathematical models are described, analyzed and ranked by weighted attributes as screening models and as validation models. For point samplers, the criteria have been developed based on EPA-approved measurement principles and procedures for testing performance characteristics and for determining a consistent relationship to reference methods. Remote monitors belong to an evolving technology that has not yet been approved as to measurement principles. Thus, criteria are developed to select certain remote sensing systems as potential candidates for air enforcement monitors. Data validation procedures are developed for the selected remote monitors. Author

N79-29198# Science Applications, Inc., La Jolla, Calif.
DEVELOPMENT OF CRITERIA FOR MONITORING OF AIRPORT GROUND POLLUTION. VOLUME 2: DATA VALIDATION PROCEDURES Final Report, Sep. 1975 - Jul. 1977
Claus B. Ludwig and J. Richard Yoder Nov. 1978 435 p refs 2 Vol.
(Contract DOT-FA76WA-3725)
(AD-A067243; SAI-77-910-LJ; FAA-RD-77-178-2) Avail: NTIS HC A19/MF A01 CSCL 01/5

Criteria are presented which will allow the FAA to methodically interrogate remotely monitored data taken for R&D and future air enforcement purposes. While interrogation in the case of air enforcement appears more straightforward than for R&D, it is more demanding because of the requirement for demonstrating equivalency. Appendixes include: (1) National Primary and Secondary Ambient Air Quality Standards (40 CFR 50); (2) Ambient Air Monitoring Reference and Equivalent Methods (40 CFR 53); (3) guidelines for public reporting of daily air quality; (4) control of air pollution from aircraft and aircraft noise; (5) review of calibration span gases; (6) list of commercially available point source samplers; (7) derivation of signal-to-noise ratio equations and error analysis; (8) meteorological instruments for use in the calibration test range; and (9) electromagnetic interference characteristics requirements for equipment. A.R.H.

N79-29199*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
A UNIQUE FACILITY FOR V/STOL AIRCRAFT HOVER TESTING
Richard G. Culpepper, Ronald D. Murphy (Naval Air Systems Command, Washington, D. C.), Edward A. Gillespie (Rockwell Intern. Corp., Columbus, Ohio), and Archie G. Lane Aug. 1979 56 p ref

(NASA-TP-1473; L-12914) Avail: NTIS HC A04/MF A01 CSCL 14B

The Langley Impact Dynamics Research Facility (IDRF) was modified to obtain static force and moment data and to allow assessment of aircraft handling qualities during dynamic tethered hover flight. Test probe procedures were also established. Static lift and control measurements obtained are presented along with results of limited dynamic tethered hover flight. J.M.S.

N79-29200# Harco Corp., Medina, Ohio.
TECHNIQUES FOR CATHODIC PROTECTION TESTING OVER AIRFIELD PAVEMENTS Final Report, Aug. 1977 - Jul. 1978
Bernard Husock Tyndall AFB, Fla. Civil and Environ. Eng. Develop. Office Apr. 1979 71 p refs
(Contract F08635-77-C-0248; AF Proj. 2104)
(AD-A069045; CEEDO-TR-78-31) Avail: NTIS HC A04/MF A01 CSCL 13/11

This report summarizes the techniques developed for cathodic protection testing over airfield pavements. Test results conclusively proved that the accuracy of all pipe-to-surface potential measurements taken over pavement surfaces are questionable. On concrete pavement it was found that potential readings differed from readings on adjacent soil by more than 100 millivolts. Potential readings over well sealed asphalt surfaces were not possible even when using high input impedance, electronic voltmeters. Potential readings over deteriorated asphalt were possible but the accuracy was poor. Accurate potential measurements over pavement surfaces can be made only if the reference electrode contacts the surface beneath the pavement. This report recommends a procedure for easily penetrating the pavement surface and installing a pavement insert through which a modified reference electrode may be inserted. GRA

N79-29248# Research Inst. of National Defence, Stockholm (Sweden).
CONSTRUCTION USING CARBON FIBER COMPOSITE MATERIALS AND ALUMINUM: A COST COMPARISON Final Report [KONSTRUKTION I KOLFIBERKOMPOSIT OCH ALUMINIUM: EN KOSTNADSJAEMFOERELSE]
Bo Holmberg and Boerje Oestman Dec. 1978 13 p refs In SWAHILI
(FOA-C-20280-F9) Avail: NTIS HC A02/MF A01

A comparison of production costs for various aircraft parts using either carbon fiber composite materials or aluminum was made. The costs involved in the use of different construction techniques, the cost of materials, and the labor costs are discussed. Previous studies on wing panels and fuel tanks as well as several types of composite materials were considered. Results show that certain construction techniques make carbon fiber composites highly competitive as compared to aluminum. Author (ESA)

N79-29270# AeroChem Research Labs., Inc., Princeton, N. J.
IONIC MECHANISMS OF CARBON FORMATION IN FLAMES Annual Report, 1 Jan. - 31 Dec. 1978
H. F. Calcote, W. J. Miller, and D. B. Olson Apr. 1979 20 p refs
(Contract F49620-77-C-0029; AF Proj. 2308)
(AD-A068872; AeroChem-TP-382; AFOSR-79-0521TR; AR-2) Avail: NTIS HC A02/MF A01 CSCL 21/2

An experimental program is underway to determine the mechanism of soot formation in flames, with particular emphasis on ionic mechanisms. Mass spectroscopic measurements of positive ion profiles through sooting and non-sooting, flat premixed flames show a large increase in the variety of ions produced when sooting occurs, with dramatic increases in the concentration of heavier ions as the combustion mixture is made fuel rich. In sooting flames, masses above 165 amu display two maxima in ion profiles through the flame. This has been confirmed by electrostatic probe measurements. The effect of changing the initial, and thus adiabatic flame temperature, on the critical equivalence ratio for soot formation was determined for acetylene and benzene. For acetylene the tendency to soot decreases with increasing adiabatic flame temperature; for benzene the tendency to soot first increases and then decreases. The data obtained in this program and data in the literature are interpreted in terms of a detailed ionic mechanism for soot formation in which chemi-ions grow by adding acetylene, polyacetylenes, and C2H. GRA

N79-29292*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AN EXPERIMENTAL, LOW-COST, SILICON SLURRY/ALUMINIDE HIGH-TEMPERATURE COATING FOR SUPERALLOYS
Stanley G. Young and Daniel L. Deadmore Jul. 1979 24 p refs
(NASA-TM-79178; E-045) Avail: NTIS HC A02/MF A01 CSCL 11F

A duplex silicon-slurry/aluminide coating has been developed and cyclically tested in Mach 1 combustion gases for oxidation and thermal fatigue resistance at 1093 C and in Mach 0.3 gases for hot-corrosion resistance at 900 C. The base-metal superalloys were VIA and B-1900. The coated B-1900 specimens performed much better in oxidation than similar specimens coated with aluminides and almost as well as the more-expensive Pt-Al and MCrAlY (where M is Ni and/or Co) coatings deposited by the physical vapor deposition process. The coating also provided good hot-corrosion protection. Metallographic, X-ray, and electron microprobe studies were made to characterize the coating, determine failure mechanisms, and study some of the changes due to exposure. Author

N79-29295# Air Force Materials Lab., Wright-Patterson AFB, Ohio.
AN ANALYSIS OF THE LOW CYCLE FATIGUE BEHAVIOR OF THE SUPERALLOY RENE 95 BY STRAINRANGE PARTITIONING Technical Report, Jan. 1977 - Jan. 1978
J. M. Hyzak and Henry L. Bernstein Nov. 1978 60 p refs
(Contract F33615-76-C-5191)
(AD-A068252; AFML-TR-78-174) Avail: NTIS HC A04/MF A01 CSCL 11/6

This report describes the results of a research program to examine the applicability of the Strainrange Partitioning (SRP) method for predicting high temperature low cycle fatigue (LCF) crack initiation. Strain controlled LCF tests were performed at 922K (1200 F) on Rene 95, a high strength nickel-base superalloy, and SRP was used to correlate the data, as well as, to predict the number of LCF cycles to failure for a series of validation tests. The data indicate that for Rene 95 compressive dwell cycles are more damaging than tensile dwell cycles, and the LCF behavior depends largely on the time in tension per cycle and on the value of the maximum tensile stress. SRP was unable to satisfactorily predict the cyclic life for several types of LCF tests because the model is not capable of accounting for particular aspects of the alloys cyclic behavior, particularly the development of mean stresses. GRA

N79-29300# Pratt and Whitney Aircraft Group, West Palm Beach, Fla. Government Products Div.
HOT SALT STRESS CORROSION STUDIES Final Report, 1 Apr. 1976 - 1 Jun. 1978
R. L. Fowler Jun. 1978 58 p refs
(Contract F33615-76-C-5155; AF Proj. 7353)
(AD-A068402; PWA-FR-10247; AFML-TR-78-121) Avail: NTIS HC A04/MF A01 CSCL 11/6

Effects of various flight-cycle simulations, maximum temperature, and microstructure were investigated using a concept analogous to a low-cycle fatigue (LCF) study. Isothermal stress cycling increased HSSC threshold stress over static loading. Simultaneous stress/temperature cycling increased threshold stress (and cyclic life) over isothermal stress cycling. A simple takeoff/shutdown dwell simulation produced the highest test results of the thermal-mechanical cycles investigated, with no significant effect from the addition of idle and cruise components. HSSC susceptibility increased with increasing maximum cyclic temperature. Alpha-beta processed material showed better resistance to HSSC than did beta material. GRA

N79-29328# Royal Aircraft Establishment, Farnborough (England).

ENVIRONMENTAL EFFECTS ON THE ELASTIC-PLASTIC PROPERTIES OF ADHESIVES IN BOND METAL JOINTS
Walter Althof, Gerhard Klinger, Gerhard Neumann, and Johanna Schlothauer Jan. 1979 97 p refs Transl. into ENGLISH "Klimaeinfluss auf die Kennwerte des Elasto-Plastischen Verhaltens von Klebstoffen in Metallklebungen" Report DLR-FB-77-63 DFVLR, Brunswick, 1977
(RAE-Lib-Trans-1999; BR67977) Avail: NTIS HC A05/MF A01

The shear modulus, the stress at 1% shear strain, the shear strength, the strain at fracture and the appertaining shear stress-strain diagrams are analyzed for ten aircraft structural adhesives. These values are calculated from the measured load-deflection behavior of the adhesives in the bond line of lap joints with a thick adherend and a small overlap length, as well as from the torsion pendulum testing of cast adhesives. The measurements are made before and after a long exposure to warmth, cold, moisture, warmth combined with moisture, and changes between cold and combined warmth and moisture. The environmental effects on the adhesion between adherend and adhesives as observed in the tests are described. Author

N79-29344# Foxboro Co., Burlington, Mass. Analytical Div.
WEAR PARTICLE ANALYSIS OF GREASE SAMPLES
E. Roderic Bowen and John P. Bowen 18 Apr. 1979 86 p refs
(Contract N68335-76-C-2281)
(AD-A069114; NAEC-92-129) Avail: NTIS HC A05/MF A01 CSCL 11/8

An investigation was conducted to analyze a number of widely used types of grease samples by Ferrography. Solvent systems were successfully formulated to dissolve these greases for analytical purposes. A number of grease samples from aircraft components were subjected to Ferrographic analysis and results reported. GRA

N79-29354*# California Univ., Los Angeles. School of Engineering and Applied Science.
FORECAST OF FUTURE AVIATION FUELS. PART 1: SCENARIOS Progress Report, 1 Aug. 1976 - 20 Sep. 1977
J. M. English, C. Y. Liu, J. L. Smith, A. K. K. Yin, G. A. Pan, M. B. Ayati, M. Gyamfi, and M. R. Arabzadah 17 Mar. 1978 140 p refs Revised
(Grant NsG-3116)
(NASA-CR-158871; UCLA-ENG-77-78-Pt-1) Avail: NTIS HC A07/MF A01 CSCL 21D

A preliminary set of scenarios is described for depicting the air transport industry as it grows and changes, up to the year 2025. This provides the background for predicting the needs for future aviation fuels to meet the requirements of the industry as new basic sources, such as oil shale and coal, which are utilized to supplement petroleum. Five scenarios are written to encompass a range of futures from a serious resource-constrained economy to a continuous and optimistic economic growth. A unique feature is the choice of one immediate range scenario which is based on a serious interruption of economic growth occasioned by an energy shortfall. This is presumed to occur due to lags in starting a synfuels program. Author

N79-29355*# Lockheed-California Co., Burbank.
EXPERIMENTAL STUDY OF LOW TEMPERATURE BEHAVIOR OF AVIATION TURBINE FUELS IN A WING TANK MODEL Final Report
Francis J. Stockemer 1979 112 p refs
(Contract NAS3-20814)
(NASA-CR-159615) Avail: NTIS HC A06/MF A01 CSCL 21D

An experimental investigation was performed to study aircraft fuels at low temperatures near the freezing point. The objective was an improved understanding of the flowability and pumpability of the fuels under conditions encoutered during cold weather flight of a long range commercial aircraft. The test tank simulated a section of an outer wing tank and was chilled on the upper and lower surfaces. Fuels included commercial Jet A and Diesel D-2; JP-5 from oil shale; and Jet A, intermediate freeze point, and D-2 fuels derived from selected paraffinic and naphthenic crudes. A pour point depressant was tested. M.M.M.

N79-29359# Exxon Research and Engineering Co., Linden, N. J. Government Research Lab.
CONTINUATION STUDY OF ALTERNATE FUELS NITROGEN CHEMISTRY Final Technical Report, 1 Feb. 1978 - 31 Jan. 1979
John W. Frankenfeld and William F. Taylor Feb. 1979 58 p refs
(Contract N00019-78-C-0177)
(AD-A069011; EXXON/GRU.2KWC.79) Avail: NTIS HC A04/MF A01 CSCL 21/4

An investigation of the effects of nitrogen compounds on sediment formation during fuel storage was carried out using model fuel systems. Various weak to non-basic nitrogen compounds, especially alkyl pyrroles and indoles were found to promote sediment formation; basic nitrogen compounds such as most amines did not. The sediment formation was strongly catalyzed by light and carboxylic acids. Phenols and aromatic thiols retard sedimentation. Sulfides and aliphatic thiols had little effect. Moisture and and traces of mineral acid also had little or no influence on sediment formation. The structure of the sediment was investigated using infrared and mass spectroscopy. GRA

N79-29364# Monsanto Research Corp., Dayton, Ohio.
ANALYSIS OF THE EMISSIONS FROM STORAGE TANKS DURING JP-4 FUEL TRANSFER OPERATIONS. PHASE 1: WARM WEATHER CONDITIONS Final Report
W. R. Feairheller 1 May 1979 66 p refs
(Contract F41608-78-C-1240)
(AD-A069339) Avail: NTIS HC A04/MF A01 CSCL 21/4

This report summarizes the warm weather phase of a program to measure the concentration of JP-4 vapor that is emitted to the atmosphere during filling of underground storage tanks. Tests were conducted with and without pressure - vacuum breather valves. Samples were analyzed by a portable total hydrocarbon analyzer containing a flame ionization detector. Data was recorded at one minute intervals during the fuel transfer operations. All data was collected during August and September 1978 from 50,000 gallon underground JP-4 fuel storage tanks at Wright-Patterson AFB, OH. Author (GRA)

N79-29397# Sperry Research Center, Sudbury, Mass.
LOW EM SIGNATURE RESPONSE TECHNIQUES Final Technical Report, Sep. 1977 - Oct. 1978
C. L. Bennett, H. Mieras, S. L. Teeter, and J. P. Tommey RADC Griffis AFB, N. Y. Mar. 1979 117 p refs
(Contract F30602-77-C-0166; AF Proj. 2314)
(AD-A068211; SCRC-CR-78-61; RADC-TR-78-287) Avail: NTIS HC A06/MF A01 CSCL 17/9

This study extends the technique for computing the smoothed impulse response to the case of scattering from triangular plates, quadrilateral plates, and more refined aircraft models that consist of a cylindrical fuselage with triangular or quadrilateral plates for the wings, stabilizers, and rudder. To the knowledge of Sperry, this is the first time that a successful solution of these problems has been obtained. The numerical techniques developed consisted of the simultaneous solution of two vector space-time integral equations. A major effort was required in order to handle non-rectangular plate geometries. The resulting numerical procedure consisted of a set of local coordinate transformations in the plate edge regions in order to be able to properly satisfy the boundary conditions on the surface currents. Results were computed for several triangular plates, finned cylinders, and a MIG-21 aircraft model. These results were found to be in good agreement with measurements taken on the Sperry time domain scattering range. In addition, measured results were obtained for the response of scattering centers when coated with RAM (Radar Abosrbing Materials). These results show that RAM can lower the scattered response but that the amount of reduction is dependent upon the spectrum of the illumination and the aspect angle. Moreover, there were several frequencies where the RCS experienced nulls of an additional 8-10 db. GRA

N79-29519 Virginia Univ., Charlottesville.
STABILITY AND NONLINEAR RESPONSE OF ROTOR-BEARING SYSTEMS WITH SQUEEZE FILM BEARINGS Ph.D. Thesis
Lloyd Edward Barrett 1978 331 p
Avail: Univ. Microfilms Order No. 7916233

A method of analyzing the first mode stability and unbalance response of multimass flexible rotors is presented whereby the multimass system is modeled as an equivalent single mass modal model including effects of rotor flexibility, general linearized hydrodynamic journal bearings, squeeze film bearing supports and rotor aerodynamic cross coupling. Expressions for optimum bearing and support damping are presented for both stability and unbalance response. The method is intended to be used as a preliminary design tool to quickly ascertain the effects of bearing and support changes on rotor-bearing system performance. Methods of calculating the nonlinear squeeze film bearing forces for finite length bearings are developed which are computationally faster than finite difference and finite element methods generally used. Dissert. Abstr.

N79-29520# Boeing Commercial Airplane Co., Seattle, Wash.
NEW CONCEPTS IN AIRCRAFT JOURNAL BEARINGS Final Report, May 1976 - Aug. 1978
W. F. Lynn Aug. 1978 96 p refs
(Contract F33615-76-C-3098; AF Proj. 2402)
(AD-A068619; AFFDL-TR-78-97) Avail: NTIS HC A05/MF A01 CSCL 13/9

An exploratory development and test program was conducted to establish optimum materials and designs for composite material journal bearings in aircraft joints between structural components of both advanced composite and conventional metallic materials. An initial study and design phase evaluated the characteristics of candidate composite materials as they apply to highly loaded bearings in adverse environments. A second phase involved fabrication and testing of journal bearing configurations. In the study and design phase, composites of epoxy resin reinforced with fibers of graphite, glass, TFE, and Kevlar were evaluated in corrosion, strength, and wear/life tests. Cost, relative weight, and suitability for commercial manufacture were considered. Also, suitability for direct substitution of composite journal bearings for currently used metallic journal bearings was a major program goal. Early testing indicated that graphite filament-reinforced composites lacked suitable friction and wear characteristics and were subject to edge breakdown due to pin bending and accepted degrees of joint misalignment. The best combination of characteristics was obtained in filament wound glass or Kevlar fibers impregnated with epoxy resins. Suitable wear/life and friction characteristics were obtained by incorporating TFE fabric or sprayed TFE-enriched resin liners in the composite journal bearings. GRA

N79-29522# Detroit Diesel Allison, Indianapolis, Ind.
GAS TURBINE ENGINES AND TRANSMISSIONS FOR BUS DEMONSTRATION PROGRAMS Technical Status Report, 28 Aug. - 30 Oct. 1978
G. J. Gomolak Oct. 1978 7 p
(Contract EM-78-C-02-4867)
(COO-4867-1) Avail: NTIS HC A02/MF A01

Progress in the procurement of gas turbine engines and automatic transmissions and the required associated software for the bus demonstration programs is reported. All hardware items were defined and were released for procurement. Engine and transmission hardware is being received, and is approximately 25 percent completed at this time. The September 1978 Cost Report and engine and transmission installation drawings were delivered to the DOE on schedule. The program is progressing as planned and all items are on schedule for delivering the first engine/transmission at the end of April 1979. DOE

N79-29531# Lockheed-Georgia Co., Marietta.
PROCEEDINGS FROM THE GOVERNMENT/INDUSTRY WORKSHOP ON THE RELIABILITY OF NONDESTRUCTIVE INSPECTIONS
W. H. Lewis, W. H. Sproat, and W. M. Pless Dec. 1978 302 p Workshop held at Houston, Tex., 2-4 Aug. 1978
(Contracts F41608-76-D-A005; F41608-77-D-A021)
(AD-A068223; LG78ER0261; SA-ALC/MME-76-6-38-2) Avail: NTIS HC A14/MF A01 CSCL 01/3

The NDI Reliability Workshop was held in Houston, Texas, on August 2-4, 1978, to present the results of the Air Force Logistics Command program, 'Determination of NDI Reliability,' and to provide a forum for evaluating the results and discussing approaches for NDI Reliability improvement. Attendance at the Workshop was limited to government and industry personnel whose primary interest was in nondestructive inspection, fracture mechanics, NDE equipment and quality assurance. The workshop consisted of formal presentations, working task groups involving all attendees, and a general discussion forum. These workshop proceedings contain a transcript of the general discussion forum which presented the task group conclusions and recommendations for nondestructive inspection improvement. GRA

N79-29532# Vought Corp. Advanced Technology Center, Inc., Dallas, Tex.
N-RAY INSPECTION OF AIRCRAFT STRUCTURES USING MOBILE SOURCES: A COMPENDUM OF RADIOGRAPHIC RESULTS Final Report, 18 May 1977 - 22 Dec. 1978
W. D. Dance 16 Apr. 1979 61 p refs
(Contract N68335-77-C-0555; WF41461406)
(AD-A068316; ATC-B-92200/8CR-137; NAEC-92-116) Avail: NTIS HC A04/MF A01 CSCL 01/3

This report presents a compendium of typical results of neutron radiographic inspections performed on aircraft structures and laboratory structural specimens. The radiographs are representative of the capability of isotope or small accelerator (nonreactor) neutron sources for imaging defects in aircraft and missile structures. The results show that: (1) the resolution and sensitivity of transportable sources are adequate for effective inspection of structures for many commonly occurring defects (the validity of the technique is established), and (2) the systems utilized to obtain these results prove the feasibility of making N-Ray systems sufficiently portable for field inspection of aircraft. Recommendations are made for implementing the transition from exploratory work to a routine field inspection capability. GRA

N79-29543# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
FATIGUE PROPERTIES OF ADHESIVE-BONDED LAMINATED SHEET MATERIAL OF ALUMINUM ALLOYS
J. Schijve, H. T. M. vanLipzig, G. F. J. A. vanGestel, and A. H. W. Hoeymakers Dec. 1978 41 p refs
(LR-276; ICAF-1086) Avail: NTIS HC A03/MF A01

Comparative fatigue tests were carried out on centrally cracked specimens and lug type specimens, both made from solid sheet and laminated sheet, consisting of five 1 mm sheets of 2024-T3 Alclad material bonded by FM 123/5. Most tests were carried out under constant amplitude loading but growth delays due to peak loads were studied also. Observations are made for through cracks and part through cracks. The significance of the results for application in aircraft structures is analyzed. Author

N79-29544# National Aerospace Lab., Emmeloord (Netherlands).
THE EFFECTS OF GUST ALLEVIATION ON FATIGUE IN 2024-T3 ALCLAD
J. B. deJonge, A. Nederveen, and P. J. Tromp 13 Jun. 1978 47 p refs
(NRL-TR-78064-U; ICAF-1059) Avail: NTIS HC A03/MF A01

Fatigue tests under flight simulation loading were done on simple notched 2024-T3 Alclad sheet specimens. Reduction of the gust load amplitudes resulted in an increase of crack initiation life but hardly influenced crack propagation. Reduction of the overall stress level increased both initiation and crack propagation life. The observed variations could be analytically predicted with varying success. Author

N79-29550# Air Force Materials Lab., Wright-Patterson AFB, Ohio.
RESIDUAL SURFACE STRAIN DISTRIBUTIONS NEAR HOLES WHICH ARE COLDWORKED TO VARIOUS DEGREES Final Report, Oct. 1975 - Sep. 1976

Gary Cloud Nov. 1978 231 p refs
(AF Proj. 2307)
(AD-A068396; AFML-TR-78-153) Avail: NTIS HC A11/MF A01 CSCL 20/11

Residual surface strain distributions were measured in the vicinity of holes in 1/4 in. aluminum alloy plate which had been coldworked to various degrees of by a commercial process. Seven levels of coldworking between 3.8 mils and 7.8 mils radial interference were studied. Attention focused mainly on radial strains, but hoop strains were measured for two coldwork levels. A sophisticated moire technique was developed for this investigation, and refined computer routines were utilized for reduction of data and plotting of results. The moire method involved high-resolution photography of a specimen grating before and after coldworking and subsequent generation of fringe patterns in a coherent optical processor. This report contains considerable tutorial detail about these techniques. The results are quite straightforward, and they are shown to agree reasonably well with the limited available data. The plastic deformation process appears to be quite complex, and minor changes of cold-working parameters can cause large changes in the strain--a factor which must be considered by designer and manufacturer. GRA

N79-29562# Royal Aircraft Establishment, Farnborough (England).

AN ANALYSIS OF A PROGRAMMED LOAD FATIGUE FAILURE

C. J. Peel 14 Jul. 1978 29 p refs
(RAE-TR-78078; BR65871) Avail: NTIS HC A03/MF A01

Premature failure of an undercarriage fitting occurred during a fatigue test, in which the cylindrical barrel of the undercarriage was internally pressurized in a programmed sequence of pressures representing landing and taxying loads. Failure occurred by the initiation of fatigue cracks at defects in the undercarraige forging and by their growth to a critical depth. An effective pressure range was calculated by comparison of the fatigue striation spacings with laboratory crack growth data. It was assumed that one cycle of the effective pressure range would proceed at the same rate of crack growth as an entire sequence of pressurizations. The effective pressure range was used to predict the fatigue life of a defect free undercarriage by reference to the pressure-fatigue life data in the literature. It was found, by this means, that the metallurgical defects had reduced the life of the cylinder by a factor of at least 6 and that they had an effective stress concentration factor in fatigue of approximately 2. The predicted crack growth rate underestimated that observed by a factor of between 2 and 3, but this analysis revealed the damaging nature of small fluctuations, in pressure, about a high mean value. Author (ESA)

N79-29772# National Technical Information Service, Springfield, Va.

WIND SHEAR, VOLUME 1. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1964-1975

Guy E. Habercom, Jr. Dec. 1978 208 p
(NTIS/PS-78/1314/0) Avail: NTIS HC $28.00/MF $28.00 CSCL 04B

The phenomena of wind shear effects in various environments are investigated in these Government-sponsored research reports. Aircraft, spacecraft launchings, atmospheric turbulence, and air/water interactions are among the areas reviewed. This updated bibliography contains 203 abstracts, none of which are new entries to the previous edition. GRA

N79-29800 Virginia Univ., Charlottesville.

DESIGN OF A MILTI-MICROPROCESSOR SYSTEM FOR REAL-TIME AIRCRAFT SIMULATION Ph.D. Thesis

Young Chang Lee 1978 208 p
Avail: Univ. Microfilms Order No. 7916283

With the use of low cost LSI microprocessors operating in parallel, a fast and yet inexpensive modularly constructed aircraft simulator is envisioned. A system architecture that yields effective parallel processing for the special purpose digital computer system is presented. Special concern is given to comparisons of the simulation accuracy obtaiable on the multimicroprocessor system as compared to that obtained on a large computer. The determination of the optimum sampling rates which would give the best simulation accuracy on the multi-microprocessor system which has a relatively short word length was studied. They are determined as functions of the characteristic frequencies of the system simulated, the word size of the digital machine, and the discretization method used for the simulation. It is concluded that the multimicroprocessor system can be used as a fast, accurate and yet low cost computing resource for certain real time aircraft simulation problems if a judicious design approach is taken. Dissert. Abstr.

N79-29938*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

COMPUTERIZED SYSTEMS ANALYSIS AND OPTIMIZATION OF AIRCRAFT ENGINE PERFORMANCE, WEIGHT, AND LIFE CYCLE COSTS

Laurence H. Fishbach 1979 22 p refs Presented at Flight Mech. Panel. Symp. on the Use of Computers as a Design Tool, Munich, 3-6 Sep. 1979; sponsored by AGARD
(NASA-TM-79221; E-112) Avail: NTIS HC A02/MF A01 CSCL 12B

The computational techniques utilized to determine the optimum propulsion systems for future aircraft applications and to identify system tradeoffs and technology requirements are described. The characteristics and use of the following computer codes are discussed: (1) NNEP - a very general cycle analysis code that can assemble an arbitrary matrix fans, turbines, ducts, shafts, etc., into a complete gas turbine engine and compute on- and off-design thermodynamic performance; (2) WATE - a preliminary design procedure for calculating engine weight using the component characteristics determined by NNEP; (3) POD DRG - a table look-up program to calculate wave and friction drag of nacelles; (4) LIFCYC - a computer code developed to calculate life cycle costs of engines based on the output from WATE; and (5) INSTAL - a computer code developed to calculate installation effects, inlet performance and inlet weight. Examples are given to illustrate how these computer techniques can be applied to analyze and optimize propulsion system fuel consumption, weight, and cost for representative types of aircraft and missions. J.M.S.

N79-29957*# Southwest Research Inst., San Antonio, Tex.

ENGINE-INDUCED STRUCTURAL-BORNE NOISE IN A GENERAL AVIATION AIRCRAFT

James F. Unruh, Dennis C. Scheidt, and Daniel J. Pomerening Aug. 1979 123 p refs
(Contract NAS1-14861; SwRI Proj. 02-4860)
(NASA-CR-159099) Avail: NTIS HC A06/MF A01 CSCL 20A

Structural borne interior noise in a single engine general aviation aircraft was studied to determine the importance of engine induced structural borne noise and to determine the necessary modeling requirements for the prediction of structural borne interior noise. Engine attached/detached ground test data show that engine induced structural borne noise is a primary interior noise source for the single engine test aircraft, cabin noise is highly influenced by responses at the propeller tone, and cabin acoustic resonances can influence overall noise levels. Results from structural and acoustic finite element coupled models of the test aircraft show that wall flexibility has a strong influence on fundamental cabin acoustic resonances, the lightweight fuselage structure has a high modal density, and finite element analysis procedures are appropriate for the prediction of structural borne noise. A.W.H.

N79-29958*# Kansas Univ. Center for Research, Inc., Lawrence.

THE EFFECT OF OBLIQUE ANGLE OF SOUND INCIDENCE, REALISTIC EDGE CONDITIONS, CURVATURE AND IN-PLANE PANEL STRESSES ON THE NOISE REDUCTION CHARACTERISTICS OF GENERAL AVIATION TYPE PANELS Progress Report

Ferd Grosveld, Jaap Lameris, and David Dunn Jul. 1979 134 p refs

(Grant NsG-1301)
(NASA-CR-157452; KU-FRL-417-10) Avail: NTIS HC A07/MF A01 CSCL 20A

Experiments and a theoretical analysis were conducted to predict the noise reduction of inclined and curved panels. These predictions are compared to the experimental results with reasonable agreement between theory and experiment for panels under an oblique angle of sound incidence. Theoretical as well as experimental results indicate a big increase in noise reduction when a flat test panel is curved. Further curving the panel slightly decreases the noise reduction. Riveted flat panels are shown to give a higher noise reduction in the stiffness-controlled frequency region, while bonded panels are superior in this region when the test panel is curved. Experimentally measured noise reduction characteristics of flat aluminum panels with uniaxial in-plane stresses are presented and discussed. These test results indicate an important improvement in the noise reduction of these panels in the frequency range below the fundamental panel/cavity frequency. A.W.H.

N79-29962# Massachusetts Inst. of Tech., Cambridge. Fluid Dynamics Research Lab.
PARAMETRIC STUDIES OF MODEL HELICOPTER BLADE SLAP AND ROTATIONAL NOISE Final Technical Report
James E. Hubbard, Jr., N. G. Humbad, Paul Bauer, and Wesley L. Harris Feb. 1979 93 p refs
(Contract DAAG29-76-C-0027)
(AD-A068181; ARO-12931.1-EX; Rept-79-1) Avail: NTIS HC A05/MF A01 CSCL 20/1

A parametric study of model helicopter rotor blade slap due to blade/vortex interaction was studied in an anechoic wind tunnel. The parameters studied were blade number, advance ratio, pitch, and shaft angle. The separate effect of each parameter was studied with other parameters held fixed. The intensity of blade slap was found to decrease with an increase in the number of blades, as the advance ratio was increased to a maximum and then decreased with higher advance ratios indicating a blade slap envelope. The intensity of blade slap was observed to be directly proportional to pitch. The intensity increased with increasing pitch until unsteady lift was encountered, at which time the intensity rapidly diminished. As the rotor shaft angle was increased, the intensity of blade slap was found to decrease to a condition of no blade slap. Directivity measurements were made of blade slap due to blade/vortex interaction in the plane normal to the tunnel wind axis. No blade slap was encountered at the intersection of the rotor disc plane and the plane normal to the tunnel wind axis. The first indication of blade slap occurred at 30 deg below the rotor disc plane and increased in intensity, reaching a maximum intensity at 90 deg below the rotor. In all studies the presence of blade slap was determined subjectively by observing and listening to the transient acoustic signature. GRA

N79-29964# Bolt, Beranek, and Newman, Inc., Canoga Park, Calif.
HELICOPTER NOISE LEVEL FUNCTIONS FOR USE IN COMMUNITY NOISE ANALYSES Final Report
William J. Galloway AMRL Wright-Patterson AFB, Ohio Jan. 1979 49 p refs
(Contract F33615-76-C-0528)
(AD-A068455; BBN-3713; AMRL-TR-78-87) Avail: NTIS HC A03/MF A01 CSCL 01/3

Acoustical data obtained from helicopters in level flight and during 6 degree approaches are used to obtain the variation of A-weighted sound exposure level and effective perceived noise level with distance. These functions are normalized to a reference airspeed which differs for individual helicopter types. Sound level functions at airspeeds different from the reference airspeed, either higher or lower, are obtained by adding a decibel increment to the reference functions. This increment is obtained by multiplying a constant, different for each helicopter, times the square of the difference between the airspeed of interest and the reference airspeed. These data are provided for the following aircraft: CH-3C, CH-47C, CH-54B, HH-53B/C, OH-6A, TH-55A, UH-1N, UH-13. Maximum A-weighted sound levels and perceived noise levels at a distance of 76 meters (250 feet) are also provided as a function of angle around the aircraft during stationary hover conditions. GRA

N79-30134# Air Force Academy, Colo.
AIR FORCE ACADEMY AERONAUTICS DIGEST, FALL 1978 Final Report
E. J. Jumper, M. M. Tower, and John P. Eaton Feb. 1979 157 p refs
(AD-A069044; USAFA-TR-79-1) Avail: NTIS HC A08/MF A01 CSCL 20/4

This digest covers unclassified research in aeronautics performed at the United States Air Force Academy during the six months ending 1 January 1979. This report includes individual technical papers in the specific areas of aerodynamics, fluid mechanics, experimental instrumentation, engineering education and thermodynamics and heat transfer. GRA

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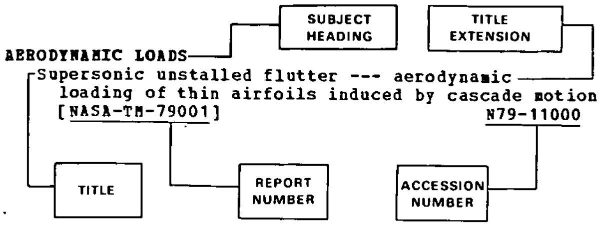

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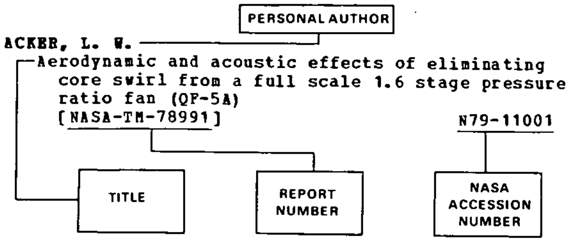

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